COULTER® MD II™ Series Analyzer

Service Manual

PN 4237242C (January 1998)

COULTER CORPORATION
Miami, Florida 33196

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Updated text for software level 1.3, updated the parts list, added specifications and procedures for the optional Epson® TM-290P Slip Printer, added information about the ISL option, and made minor corrections. The following pages were changed or added: vi, vii-xv, 2-ii, 2-iii, 2.13, 2.2-2, 2.4-5, 2.4-9, 2.4-12, 2.4-13, 3-i, 3.1-2, 3.2-1, 3.2-3, 3.4-1 through 3.4-4, 4.28-1, 4.28-2, 5.1-1, 5.2-1, 7.4-1, 8-i, 8.1-8 through 8.1-7, 8.2-1, 8.2-2, 8.2-4, 8.2-5, 8.2-8, 8.2-9, 8.2-12, A-i, A.1-1, A.2-1 through A.2-4, A.5-1, D-i, D.1-1, D.1-2, E-i, E.1-1 and INDEX-1 through INDEX-11.

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This document applies to the latest software listed and higher versions. When a subsequent software version affects the information in this document, the changes will be summarized on a Notice of Information Update form and will be released by service memo.

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LEGAL NOTICES

REVISION STATUS, i

CONTENTS, iii

1 INTRODUCTION, 1.1-1

1.1 MANUAL DESCRIPTION, 1.1-1
- Scope, 1.1-1
- Organization, 1.1-1
- Numbering Format, 1.1-1
- Special Headings, 1.1-1
  - WARNING, 1.1-1
  - CAUTION, 1.1-2
  - IMPORTANT, 1.1-2
  - ATTENTION, 1.1-2
  - Note, 1.1-2
- Conventions, 1.1-2

1.2 SAFETY PRECAUTIONS, 1.2-1
- Electronic, 1.2-1
- Biological, 1.2-1
- Troubleshooting, 1.2-2

2 INSTRUMENT DESCRIPTION, 2.1-1

2.1 SYSTEM OVERVIEW, 2.1-1
- Description, 2.1-1
- Software Menu System, 2.1-2
- Software Tables, 2.1-2
  - Aspirate Table, 2.1-5
  - Power-up Table, 2.1-6

2.2 POWER SUPPLY, 2.2-1
  - Overview, 2.2-1
- AT Power Supply, 2.2-1
  - Inputs, 2.2-1
  - Outputs, 2.2-1
  - Switches, 2.2-2
- AC Power/Vacuum Relay Card, 2.2-2
  - Inputs, 2.2-5
  - Outputs, 2.2-5
  - Test Points, 2.2-5
  - Jumpers, 2.2-5
- +24 Volt Switching Power Supply, 2.2-6
  - Inputs, 2.2-6
  - Outputs, 2.2-6
  - Adjustments, 2.2-6
- Linear Power Supply Card, 2.2-6
  - Inputs, 2.2-8
  - Outputs, 2.2-8

Test Points, 2.2-8
Jumpers, 2.2-8

2.3 FLUIDICS PANEL, 2.3-1
Overview, 2.3-1
Diluter Panel, 2.3-2
Probe/Wipe Traverse Assembly, 2.3-4
Peristaltic Pump Assembly, 2.3-5
Syringe Assembly, 2.3-6
Individual Components Mounted to Fluidics Panel, 2.3-7
Cycle Counter and Air Solenoids, 2.3-7
Diluent Reservoir, 2.3-7
Flex Connect Card, 2.3-7
Lyse Pump (PM5), 2.3-8
Solenoid Interconnect Card, 2.3-8
Vacuum Regulator, 2.3-9

2.4 SYSTEM CONTROL, 2.4-1
AT Motherboard, 2.4-1
Switches and Jumpers, 2.4-1
User Resource Adapter (URA) Card, 2.4-2
Keypad Controller, 2.4-3
Display Controller, 2.4-3
CMOS RAM, 2.4-3
Diagnostic Data Acquisition Circuit, 2.4-4
Utility Timer Circuit, 2.4-4
Support Circuits, 2.4-4
Inputs, 2.4-5
Outputs, 2.4-5
Adjustments, 2.4-5
Switches and Jumpers, 2.4-6
Diluter Resource Adapter (DRA) Card, 2.4-6
Motor Controller, 2.4-6
Solenoid Controller, 2.4-7
Support Circuitry, 2.4-7
Inputs, 2.4-7
Outputs, 2.4-7
Jumpers, 2.4-8
Motor/Solenoid Driver Card, 2.4-8
Motor Driver, 2.4-9
Solenoid Driver, 2.4-9
Sensor Control, 2.4-9
+24 V POWER ON Signal, 2.4-9
+24 V POWERFAIL (PF/PG) Signal, 2.4-10
Inputs, 2.4-10
Outputs, 2.4-10
Test Points, 2.4-11
Jumpers, 2.4-11

2.5 DATA ACQUISITION, 2.5-1
Sensor Preamp Adapter (SPA) Card, 2.5-1
Inputs, 2.5-1
Outputs, 2.5-2
Adjustments, 2.5-2
Jumpers, 2.5-2
Hgb Preamp Card, 2.5-3
Inputs, 2.5-4
Outputs, 2.5-4
Adjustments, 2.5-4
Test Points, 2.5-4
Vacuum Sensor Card, 2.5-4
Inputs, 2.5-5
Outputs, 2.5-5
Adjustments, 2.5-5
Test Points, 2.5-6
Sensor Processing Adapter with Diagnostics (SPAD) Card, 2.5-6
Power Supply Conditioning, 2.5-7
Oscillator Circuit, 2.5-7
Control Functions, 2.5-7
Octal Digital-to-Analog Converter (DAC), 2.5-8
Aperture Signal Processing, 2.5-8
Data Acquisition Circuit, 2.5-8
Test Pulse Generator, 2.5-9
Interrupt Selector, 2.5-9
Input, 2.5-9
Outputs, 2.5-9
Jumper, 2.5-10
Adjustments, 2.5-10

2.6 PERIPHERALS, 2.6-1
Floppy Disk Drive, 2.6-1
Display, 2.6-1
Keypad, 2.6-1
Rear Panel Interface Connectors, 2.6-1

3 INSTALLATION PROCEDURES, 3.1-1

PART A: INSTRUMENT INSTALLATION

3.1 PREINSTALLATION CHECKS, 3.1-1
Space and Accessibility Requirements, 3.1-1
Power Requirements, 3.1-1

3.2 INITIAL SETUP, 3.2-1
Unpack the Instrument, 3.2-1
Connect the Reagents, 3.2-2
Connect the Printer, 3.2-3
Enter the Initial Settings, 3.2-4

3.3 INSTRUMENT VERIFICATION, 3.3-1
Startup the Instrument, 3.3-1
Calibrate the Instrument, 3.3-1

PART B: UPGRADE AND OPTION INSTALLATION

3.4 OPTIONAL TICKET PRINTERS, 3.4-1
Epson TM-290P Slip Printer, 3.4-1
Purpose, 3.4-1
Single-Printer Setup Procedure, 3.4-1
Two-Printer Setup Procedure, 3.4-3

4 SERVICE AND REPAIR PROCEDURES, 4.1-1

4.1 GUIDELINES, 4.1-1

4.2 ACCESSING THE HIDDEN SERVICE MENU ITEMS, 4.2-1
Accessing Service Report, 4.2-1
Purpose, 4.2-1
Procedure, 4.2-1
Accessing Service Diagnostic, 4.2-1
Purpose, 4.2-1
Procedure, 4.2-1
System Reboot, 4.2-2

4.3 REMOVING THE TOP COVER, 4.3-1

4.4 OPENING THE LOWER CHASSIS, 4.4-1

4.5 AT POWER SUPPLY, 4.5-1
Tools/Supplies Needed, 4.5-1
Removal, 4.5-1
Installation, 4.5-1
Verification, 4.5-2

4.6 AT MOTHERBOARD, 4.6-1
Tools/Supplies Needed, 4.6-1
Removal, 4.6-1
Installation, 4.6-2
Verification, 4.6-3

4.7 SENSOR PROCESSING ADAPTER WITH DIAGNOSTICS (SPAD) CARD, 4.7-1
Tools/Supplies Needed, 4.7-1
Removal, 4.7-1
Installation, 4.7-1
Verification, 4.7-2

4.8 USER RESOURCE ADAPTER (URA) CARD, 4.8-1
Tools/Supplies Needed, 4.8-1
Removal, 4.8-1
Installation, 4.8-2
Verification, 4.8-2

4.9 DILUTER RESOURCE ADAPTER (DRA) 1 AND 2 CARDS, 4.9-1
Tools/Supplies Needed, 4.9-1
Removal, 4.9-1
Installation, 4.9-2
Verification, 4.9-2

4.10 MEMBRANE KEYPAD AND DISPLAY, 4.10-1
Tools/Supplies Needed, 4.10-1
Removal, 4.10-1
Installation, 4.10-2
Verification, 4.10-2

4.11 AC POWER/VACUUM RELAY CARD, 4.11-1
Tools/Supplies Needed, 4.11-1
Removal, 4.11-1
Installation, 4.11-1
Verification, 4.11-2

4.12 +24 VOLT SWITCHING POWER SUPPLY, 4.12-1
Tools/Supplies Needed, 4.12-1
Removal, 4.12-1
Installation, 4.12-2
Verification, 4.12-3

4.13 LINEAR POWER SUPPLY CARD, 4.13-1
Tools/Supplies Needed, 4.13-1
Removal, 4.13-1
Installation, 4.13-2
Verification, 4.13-3

4.14 VACUUM SENSOR CARD, 4.14-1
Tools/Supplies Needed, 4.14-1
Removal, 4.14-1
Installation, 4.14-2
Verification, 4.14-2

4.15 MOTOR/SOLENOID DRIVER CARD, 4.15-1
Tools/Supplies Needed, 4.15-1
Removal, 4.15-1
Installation, 4.15-1
Verification, 4.15-2

4.16 SENSOR PREAMP ADAPTER (SPA) CARD, 4.16-1
Tools/Supplies Needed, 4.16-1
Removal, 4.16-1
Installation, 4.16-2
Verification, 4.16-3

4.17 PROBE AND PROBE WIPE, 4.17-1
Tools/Supplies Needed, 4.17-1
Removal, 4.17-1

Installation, 4.17-2
Verification, 4.17-3

4.18 PROBE MOTOR, 4.18-1
Tools/Supplies Needed, 4.18-1
Removal, 4.18-1
Installation, 4.18-1
Verification, 4.18-1

4.19 TRAVERSE DRIVE BELT, 4.19-1
Tools/Supplies Needed, 4.19-1
Removal, 4.19-1
Installation, 4.19-2
Verification, 4.19-3

4.20 TRAVERSE MOTOR, 4.20-1
Tools/Supplies Needed, 4.20-1
Removal, 4.20-1
Installation, 4.20-2
Verification, 4.20-3

4.21 SYRINGE ASSEMBLY, 4.21-1
Tools/Supplies Needed, 4.21-1
Removal, 4.21-1
Installation, 4.21-3
Verification, 4.21-4

4.22 PERISTALTIC PUMP MOTOR AND SPOOL, 4.22-1
Tools/Supplies Needed, 4.22-1
Removal, 4.22-1
Installation, 4.22-2
Verification, 4.22-2

4.23 VACUUM PUMP, 4.23-1
Tools/Supplies Needed, 4.23-1
Removal, 4.23-1
Installation, 4.23-1
Verification, 4.23-1

4.24 APERTURE, BATH AND APERTURE ELECTRODE MODULE, 4.24-1
Tools/Supplies Needed, 4.24-1
Removal, 4.24-1
Installation, 4.24-2
Verification, 4.24-3

4.25 DILUTER PANEL SOLENOIDS, 4.25-1
Tools/Supplies Needed, 4.25-1
Removal, 4.25-1
Installation, 4.25-1
Verification, 4.25-1

4.26 SWEEP-FLOW TUBING, 4.26-1
Tools/Supplies Needed, 4.26-1
Removal, 4.26-1
Installation, 4.26-2
Verification, 4.26-2

4.27 LATEX GAIN ADJUSTMENT, 4.27-1
Tools/Supplies Needed, 4.27-1
Procedure, 4.27-1

4.28 AIM ADJUSTMENT, 4.28-1
Tools/Supplies Needed, 4.28-1
Procedure, 4.28-1
Optional Procedures, 4.28-1
Option 1, 4.28-1
Option 2, 4.28-2

4.29 HGB PREAMP ADJUSTMENT, 4.29-1
Tools/Supplies Needed, 4.29-1
Procedure, 4.29-1

4.30 VACUUM ADJUSTMENT, 4.30-1
Procedure, 4.30-1

4.31 LYSE VOLUME ADJUSTMENT/VERIFICATION, 4.31-1
Tools/Supplies Needed, 4.31-1
Procedure, 4.31-1

5 MAINTENANCE PROCEDURES, 5.1-1

5.1 SYSTEM VERIFICATION PROCEDURE (SVP), 5.1-1

5.2 PMI RECOMMENDATIONS, 5.2-1
Components, 5.2-1
Filters, 5.2-1
Peristaltic Pump Tubing, 5.2-1
Polyurethane Tubing, 5.2-1
Syringes, 5.2-1
Cleaning, 5.2-1
Adjustment Procedures, 5.2-2
Verification Procedures, 5.2-2

6 SCHEMATICS AND BLOCK DIAGRAMS, 6.1-1

6.1 DOCUMENT CONTROL NUMBERS AND DESCRIPTIONS, 6.1-1

6.2 SCHEMATICS, 6.2-1

7 TROUBLESHOOTING, 7.1-1

7.1 TROUBLESHOOTING DIAGNOSTICS, 7.1-1
Customer Options Available for Troubleshooting, 7.1-1
Service Menu, 7.1-2

7.2 GENERATING A SERVICE REPORT, 7.2-1
The Screen Display, 7.2-1
The Printed Report, 7.2-1
AIM Criteria Results, 7.2-2
Hgb Data, 7.2-3
Sample Results - DO NOT REPORT, 7.2-3

7.3 SERVICE DIAGNOSTIC, 7.3-1

7.4 TROUBLESHOOTING ERROR MESSAGES, 7.4-1

7.5 TROUBLESHOOTING POWER-UP PROBLEMS, 7.5-1

8 PARTS LISTS, 8.1-1

8.1 MASTER PARTS LISTS, 8.1-1

8.2 ILLUSTRATED PARTS, 8.2-1

A QUICK REFERENCE INFORMATION, A.1-1

A.1 TOLERANCES, VOLTAGES AND LIMITS, A.1-1
Limits, A.1-1
Adjustments, A.1-1

A.2 SWITCH SETTINGS, JUMPER SETTINGS AND TEST POINTS, A.2-1
AC Power/Vacuum Relay Card, A.2-1
Connectors, A.2-1
Test Points, A.2-1
AT Motherboard, A.2-1
DRA Card, A.2-2
Hgb Preamp Card, A.2-2
Test Points, A.2-2
Linear Power Supply Card, A.2-2
Jumpers, A.2-2
Test Points, A.2-2
Motor/Solenoid Driver Card, A.2-3
Jumpers, A.2-3
Test Points, A.2-3
Sensor Preamp Adapter Card, A.2-4
SPAD Card, A.2-4
URA Card, A.2-4
Vacuum Sensor Card, A.2-4

A.3 PRINTER SETTINGS, A.3-1

A.4 FUNCTIONS, A.4-1
Peristaltic Pumps, A.4-1

A.5 MENU TREE, A.5-1

B PROCEDURES FOR SPECIAL TOOLS OR SOFTWARE, B.1-1

B.1 PROCEDURES FOR SPECIAL TOOLS OR SOFTWARE, B.1-1

C MESSAGE/ERROR CODE LISTINGS, C.1-1

C.1 INSTRUMENT NON-FATAL ERROR MESSAGES, C.1-1

C.2 INSTRUMENT FATAL ERROR MESSAGES, C.2-1

C.3 AMIBIOS BEEP CODES, C.3-1

D OPTIONAL PRINTERS, D.1-1

D.1 EPSON TM-290P SLIP PRINTER, D.1-1
Specifications, D.1-1
Operator Controls and LEDs, D.1-1
DIP Switch SW1 Settings, D.1-2
Installation Procedure, D.1-2
Printer Self-Test, D.1-2

E INTELLIGENT SOFTWARE LINK (ISL) OPTION, E.1-1

E.1 ISL OPTION FOR RALS, E.1-1
ISL Description, E.1-1
RALS Installation, Training and Service Responsibilities, E.1-1
Recognizing an MD II Linked to RALS, E.1-1
Servicing an MD II Linked to RALS, E.1-1

TRADEMARKS

ILLUSTRATIONS

2.1-1 Functional Diagram, 2.1-1
2.1-2 Software Menu Tree, 2.1-3
2.2-1 Top View into Upper Chassis, 2.2-3
2.2-2 Top View into Lower Chassis, 2.2-4
2.2-3 AC Power/Vacuum Relay Card, 2.2-5
2.2-4 Linear Power Supply Card, 2.2-7
2.3-1 Fluidics Panel Components, 2.3-1
2.3-2 Diluter Panel, 2.3-3
2.3-3 Probe-Wipe Traverse Assembly, 2.3-5
2.3-4 Peristaltic Pump Assembly, 2.3-5
2.3-5 Syringe Assembly, 2.3-6
2.4-1 AT Motherboard, 2.4-2
2.4-2 URA Card, 2.4-5
2.4-3 DRA Card, 2.4-8
2.4-4 Motor/Solenoid Driver Card, 2.4-12
2.5-1 Sensor Preamp Adapter Card, 2.5-3
2.5-2 Vacuum Sensor Card Block Diagram, 2.5-5
2.5-3 Vacuum Sensor Card, 2.5-6
2.5-4 SPAD Card, 2.5-10
3.1-1 System Electrical Connectors, 3.1-2
3.2-1 Reagent Connections, 3.2-2
3.2-2 System Electrical Connections, 3.2-3
3.2-3 CITIZEN GSX-190 Printer settings, 3.2-4
3.4-1 Epson TM-290P Slip Printer, 3.4-1
3.4-2 DIP Switch, SW1, Location, 3.4-2
3.4-3 Printer Connections for a Single Printer, 3.4-2
3.4-4 Printer Connections for Two Printers, 3.4-4
4.3-1 Top View into Upper Chassis, 4.3-1
4.4-1 Top View into Lower Chassis, 4.4-1
4.6-1 Card Removal (AT Motherboard, URA, DRAs and SPAD), 4.6-1
4.6-2 AT Motherboard, 4.6-3
4.8-1 URA Card, 4.8-1
4.9-1 DRA Card, 4.9-1
4.10-1 Membrane Keypad and Display, 4.10-1
4.12-1 +24 V Power Supply, 4.12-1
4.13-1 Linear Power Supply Card, 4.13-1
4.13-2 Back View of MD II with Rear Panel Door Opened, 4.13-2
4.14-1 Vacuum Sensor Card, 4.14-1
4.15-1 Motor/Solenoid Driver Card, 4.15-2
4.16-1 Sensor Preamp Adapter (SPA) Card and Surrounding Components, 4.16-1
4.16-2 Sensor Preamp Adapter Card, 4.16-3
4.17-1 Probe Assembly, 4.17-1
4.19-1 Traverse Drive Belt, 4.19-1
4.20-1 Traverse Motor, 4.20-1
4.21-1 Syringe Assembly, 4.21-2
4.22-1 Peristaltic Pump Motors, 4.22-1
4.24-1 Aperture Bath Assembly, 4.24-1
4.26-1 Sweep-Flow Tubing, 4.26-1

7.2-1 Sample Screen Display, 7.2-1
7.2-2 Sample Printed Report, 7.2-2
7.2-3 Hgb Results Analysis, 7.2-4
7.5-1 Power-Up Troubleshooting Flowchart (part 1 of 2), 7.5-1
7.5-2 Power-Up Troubleshooting Flowchart (part 2 of 2), 7.5-2
8.2-1 MD II, Lower Chassis, Left Side View (See Table 8.2-1), 8.2-1
8.2-2 MD II, Front View (See Table 8.2-2), 8.2-2
8.2-3 MD II, Top View into Lower Chassis (See Table 8.2-3), 8.2-3
8.2-4 MD II, Upper Chassis (See Table 8.2-4), 8.2-4
8.2-5 MD II, Back View (See Table 8.2-5), 8.2-5
8.2-6 Traverse Assembly (See Table 8.2-6), 8.2-6
8.2-7 Diluter Assembly (See Table 8.2-6), 8.2-8
8.2-8 Syringe Assembly (See Table 8.2-8), 8.2-10
8.2-9 Peristaltic Pump Assembly (See Table 8.2-9), 8.2-12
A.3-1 CITIZEN GSX-190 Printer Settings, A.3-1
A.5-1 Software Menu Tree, A.5-1
D.1-1 Epson TM-290P Slip Printer Control Locations, D.1-1

TABLES

2.1-1 Functions the Diluter Table Can Use, 2.1-4
2.1-2 Aspiration Cycle, 2.1-5
2.1-3 Power-Up Cycle, 2.1-6
2.2-1 AT Power Supply Output Connectors, 2.2-1
2.2-2 AC Power/Vacuum Relay Card Connectors and Line Input Ranges, 2.2-6
2.2-3 Linear Power Supply Card Test Points, 2.2-8
2.3-1 Diluter Panel Solenoids and Their Function, 2.3-4
2.3-2 Peristaltic Pumps Location and Function, 2.3-6
2.3-3 Flex Connect Card Connectors and LEDs, 2.3-7
2.3-4 Solenoid Interconnect Card Connectors and LEDs, 2.3-8
2.4-1 AT Motherboard Switch and Jumper Settings, 2.4-1
2.4-2 URA Card Switch and Jumper Settings, 2.4-6
2.4-3 DRA Card Output Connectors, 2.4-7
2.4-4 DRA Card Jumper Settings, 2.4-8
2.4-5 Motor/Solenoid Driver Card Input Connections, 2.4-10
2.4-6 Motor/Solenoid Driver Card Output Connections, 2.4-10
2.4-7 Motor/Solenoid Driver Card Test Points, 2.4-11
2.4-8 Motor/Solenoid Driver Card Jumper Settings, 2.4-11
2.5-1 Sensor Preamp Adapter Card Input Connections, 2.5-1
2.5-2 Sensor Preamp Adapter Card Output Connections, 2.5-2
2.5-3 Sensor Preamp Adapter Card Jumper Settings, 2.5-2
2.5-4 Vacuum Sensor Card Test Points, 2.5-6
2.5-5 SPAD Card Input Connections, 2.5-9
2.6-1 Pinouts for Serial Ports, 2.6-1
3.1-1 Space Requirements, 3.1-1
3.1-2 Connectors' Part Numbers and Line Input Ranges, 3.1-2
6.1-1 DCNs and Descriptions for Schematics Included in This Manual, 6.1-1
6.1-2 DCNs and Descriptions for Schematics Not Included in This Manual, 6.1-1
7.1-1 Diluter Functions Menu Options, 7.1-1
7.1-2 Service Menu Options, 7.1-2
7.3-1 Service Diagnostic Cycle, 7.3-1
7.4-1 Error Messages, 7.4-1
8.1-1 Cables, 8.1-1
8.1-2 Lower Chassis, 8.1-2
8.1-3 Peripherals and Support, 8.1-5
8.1-4 Upper Chassis, 8.1-6
8.1-5 Miscellaneous Hardware, 8.1-7
8.2-1 MD II, Lower Chassis, Left Side View (See Figure 8.2-1), 8.2-1
8.2-2 MD II, Front View (See Figure 8.2-2), 8.2-2
8.2-3 MD II, Top View into Lower Chassis (See Figure 8.2-3), 8.2-3
8.2-4 MD II, Upper Chassis (See Figure 8.2-4), 8.2-4
8.2-5 MD II, Back View (See Figure 8.2-5), 8.2-5
8.2-6 Traverse Assembly (See Figure 8.2-6), 8.2-7
8.2-7 Diluter Assembly (See Figure 8.2-7), 8.2-9
8.2-8 Syringe Assembly (See Figure 8.2-8), 8.2-11
8.2-9 Peristaltic Pump Assembly (See Figure 8.2-9), 8.2-13
A.1-1 Calibration Factor Limits, A.1-1
A.1-2 Amplifier Noise Limits, A.1-1

A.1-3 Adjustments, A.1-1
A.2-1 AC Power/Vacuum Relay Card Connectors and Line Input Ranges, A.2-1
A.2-2 AT Motherboard Switch and Jumper Settings, A.2-1
A.2-3 DRA Card Jumper Settings, A.2-2
A.2-4 Linear Power Supply Card Jumper Settings, A.2-2
A.2-5 Linear Power Supply Card Test Points, A.2-2
A.2-6 Motor/Solenoid Driver Card Jumper Settings, A.2-3
A.2-7 Motor/Solenoid Driver Card Test Points, A.2-3
A.2-8 Sensor Preamp Adapter Card Jumper Settings, A.2-4
A.2-9 URA Card Switch and Jumper Settings, A.2-4
A.2-10 Vacuum Sensor Card Test Points, A.2-4
A.4-1 Peristaltic Pumps Location and Function, A.4-1
C.1-1 Non-fatal Error Messages, C.1-1
C.2-1 Fatal Error Messages, C.2-1
C.3-1 AT Motherboard AMIBIOS Beep Codes, C.3-1
D.1-1 DIP Switch SW1 Position Settings, D.1-2
D.1-2 DIP Switch SW1 Settings for International Character Sets, D.1-2

1 **INTRODUCTION, 1.1-1**

1.1 MANUAL DESCRIPTION, 1.1-1
Scope, 1.1-1
Organization, 1.1-1
Numbering Format, 1.1-1
Special Headings, 1.1-1
WARNING, 1.1-1
CAUTION, 1.1-2
IMPORTANT, 1.1-2
ATTENTION, 1.1-2
Note, 1.1-2
Conventions, 1.1-2

1.2 SAFETY PRECAUTIONS, 1.2-1
Electronic, 1.2-1
Biological, 1.2-1
Troubleshooting, 1.2-2

1.1 MANUAL DESCRIPTION

Scope

This manual provides the reference information and procedures necessary for servicing and maintaining the COULTER® MD II™ Series analyzer.

This manual is to be used in conjunction with the appropriate customer documents and does not contain information and procedures already covered in those documents. There are five COULTER® MD II™ Series analyzer customer documents available for reference:

- Host Transmission Specification, PN 4237198
- Operator's Guide, PN 4237235
- Quip-Tip Card, PN 4237277
- Reference, PN 4237236
- Training Guide, PN 4237271.

Organization

The material in this manual is organized into eight chapters. Chapter 1 includes a brief description of this manual and essential safety information. Chapter 2 introduces the COULTER MD II Series analyzer, hereafter referred to as the MD II or the instrument, and describes how it functions. Chapters 3 through 5 contain the procedures for installing, repairing and maintaining the instrument. Chapters 6 through 8 contain information required for servicing the instrument: schematics, troubleshooting tables and a parts list. Appendices A through C contain quick reference tables showing: instrument limits, instrument adjustments, switch and jumper settings, and error messages/codes, and also procedures for using the Service Diagnostics diskette.

Numbering Format

Each chapter of this manual is further divided into topics, which are numbered sequentially, beginning at one. The numbering format for the topic heading, which is called the primary heading, is chapter number, decimal point, topic number. For example, the primary heading number for the fifth topic covered in Chapter 2 is 2.5.

The page, figure and table numbers are tied directly to the primary heading number. For example, Heading 2.5 begins on page 2.5-1, the first figure under Heading 2.5 is Figure 2.5-1, and the first table under Heading 2.5 is Table 2.5-1.

Note: Primary headings always begin on the top of a right-hand page.

Special Headings

Throughout this manual WARNING, CAUTION, IMPORTANT, Attention and Note headings are used to indicate potentially hazardous situations and important or helpful information.

WARNING

A **WARNING** indicates a situation or procedure that, if ignored, can cause serious personal injury. The word **WARNING** is boldfaced in the printed manual and is red in the online manual.

CAUTION

A **CAUTION** indicates a situation or procedure that, if ignored, can cause damage to equipment. The word **CAUTION** is boldfaced in the printed manual and is red in the online manual.

IMPORTANT

An **IMPORTANT** indicates a situation or procedure that, if ignored can result in erroneous test results. The word **IMPORTANT** is boldfaced in the printed manual and is red in the online manual.

ATTENTION

An **ATTENTION** contains information that is critical for the successful completion of a procedure and/or operation of the instrument. The word **ATTENTION** is boldfaced in the printed manual and is red in the online manual.

Note

A Note contains information that is important to remember or helpful in performing a procedure.

Conventions

This manual uses the following conventions. An example is given below each convention.

- Italics indicate screen messages.

  The MD II screen displays *ERROR CODE (018) Copy Protection Violation* when the instrument detects the wrong resource files on the Program Disk.

- Courier font indicates text that you have to type.

  When the instrument prompts you for a password, type `123`.

- Bold, all uppercase text indicates a menu option for you to select. The item number key next to the menu item next to it, indicates the item number key you have to press to select the menu option. The menu item is displayed on the screen but only the item number key is on the instrument's keypad.

  From the Main Menu select **5 SPECIAL FUNCTIONS**.

- Select menu item ▸▸ sub-menu item indicates the software options you have to select, as well as the order in which you should select them.

  From the Main Menu, select **5 SPECIAL FUNCTIONS** ▸▸ **4 SUPERVISOR** ▸▸ **7 SERVICE DIAGNOSTICS**.

- In the online manual, blue, underlined text indicates a link to additional information. To access the linked information, select the blue, underlined text.

1.2 SAFETY PRECAUTIONS

Electronic

WARNING Risk of personal injury. Rings or other jewelry can contact exposed electronic components causing personal injury from electronic shock. Remove rings and other metal jewelry before performing maintenance or service on the electronic components of the instrument.

CAUTION Risk of damage to electronic components. If removal/replacement of printed circuit card or components is performed while power is ON, damage to components may occur. To prevent damage to delicate electronic components, always make sure power is OFF before removing or replacing printed circuit cards and components.

CAUTION Risk of damage to electronic components. Electrostatic discharge (ESD) can damage disk drives, add-in circuit cards and other electronic components. Perform any procedures where there is a possibility of ESD damage, at an ESD workstation or wear an antistatic wrist strap attached to a metal part of the chassis that is connected to an earth ground.

Biological

WARNING Risk of personal injury or contamination. If service personnel do not properly shield themselves while servicing the instrument with the doors open, they may become injured or contaminated. To prevent possible injury or biological contamination, service personnel must wear gloves, a laboratory coat and eye protection when servicing the instrument with the doors open

Use care when working with pathogenic materials. Means must be available to decontaminate the instrument, provide ventilation, and to dispose of waste liquid. Refer to the following publications for further guidance on decontamination.

Biohazards Safety Guide, 1974, National Institute of Health.

Classifications of Etiological Agents on the Basis of Hazards, 3d ed., June 1974, Center for Disease Control, U.S. Public Health Service.

Troubleshooting

Bring the following warning to the customer's attention before advising the customer to perform any maintenance, troubleshooting, or service procedures on their instrument.

WARNING Risk of personal injury or contamination. If operators do not properly shield themselves while performing service, maintenance and troubleshooting procedures, residual fluids in the instrument could injure or contaminate them. Coulter recommends that barrier protection, such as appropriate safety glasses, laboratory coat, and gloves be worn throughout the performance of service, maintenance and troubleshooting procedures to avoid contact with cleaners and residual fluids in the instrument.

WARNING Risk of personal injury. If non-Coulter-trained personnel attempt to service the instrument by performing adjustment and measurements with the power ON, injury could result. Only Coulter-trained Service personnel should service this instrument.

2 2 INSTRUMENT DESCRIPTION, 2.1-1

2.1 SYSTEM OVERVIEW, 2.1-1
Description, 2.1-1
Software Menu System, 2.1-2
Software Tables, 2.1-2
Aspirate Table, 2.1-5
Power-up Table, 2.1-6

2.2 POWER SUPPLY, 2.2-1
Overview, 2.2-1
AT Power Supply, 2.2-1
Inputs, 2.2-1
Outputs, 2.2-1
Switches, 2.2-2
AC Power/Vacuum Relay Card, 2.2-2
Inputs, 2.2-5
Outputs, 2.2-5
Test Points, 2.2-5
Jumpers, 2.2-5
+24 Volt Switching Power Supply, 2.2-6
Inputs, 2.2-6
Outputs, 2.2-6
Adjustments, 2.2-6
Linear Power Supply Card, 2.2-6
Inputs, 2.2-8
Outputs, 2.2-8
Test Points, 2.2-8
Jumpers, 2.2-8

2.3 FLUIDICS PANEL, 2.3-1
Overview, 2.3-1
Diluter Panel, 2.3-2
Probe/Wipe Traverse Assembly, 2.3-4
Peristaltic Pump Assembly, 2.3-5
Syringe Assembly, 2.3-6
Individual Components Mounted to Fluidics Panel, 2.3-7
Cycle Counter and Air Solenoids, 2.3-7
Diluent Reservoir, 2.3-7
Flex Connect Card, 2.3-7
Lyse Pump (PM5), 2.3-8
Solenoid Interconnect Card, 2.3-8
Vacuum Regulator, 2.3-9

2.4 SYSTEM CONTROL, 2.4-1
AT Motherboard, 2.4-1
Switches and Jumpers, 2.4-1
User Resource Adapter (URA) Card, 2.4-2
Keypad Controller, 2.4-3
Display Controller, 2.4-3
CMOS RAM, 2.4-3

Diagnostic Data Acquisition Circuit, 2.4-4
Utility Timer Circuit, 2.4-4
Support Circuits, 2.4-4
Inputs, 2.4-5
Outputs, 2.4-5
Adjustments, 2.4-5
Switches and Jumpers, 2.4-6
Diluter Resource Adapter (DRA) Card, 2.4-6
Motor Controller, 2.4-6
Solenoid Controller, 2.4-7
Support Circuitry, 2.4-7
Inputs, 2.4-7
Outputs, 2.4-7
Jumpers, 2.4-8Motor/Solenoid Driver Card, 2.4-8
Motor Driver, 2.4-9
Solenoid Driver, 2.4-9
Sensor Control, 2.4-9
+24 V POWER ON Signal, 2.4-9
+24 V POWERFAIL (PF/PG) Signal, 2.4-10
Inputs, 2.4-10
Outputs, 2.4-10
Test Points, 2.4-11
Jumpers, 2.4-11

2.5 DATA ACQUISITION, 2.5-1
Sensor Preamp Adapter (SPA) Card, 2.5-1
Inputs, 2.5-1
Outputs, 2.5-2
Adjustments, 2.5-2
Jumpers, 2.5-2
Hgb Preamp Card, 2.5-3
Inputs, 2.5-4
Outputs, 2.5-4
Adjustments, 2.5-4
Test Points, 2.5-4
Vacuum Sensor Card, 2.5-4
Inputs, 2.5-5
Outputs, 2.5-5
Adjustments, 2.5-5
Test Points, 2.5-6
Sensor Processing Adapter with Diagnostics (SPAD) Card, 2.5-6
Power Supply Conditioning, 2.5-7
Oscillator Circuit, 2.5-7
Control Functions, 2.5-7
Octal Digital-to-Analog Converter (DAC), 2.5-8
Aperture Signal Processing, 2.5-8
Data Acquisition Circuit, 2.5-8
Test Pulse Generator, 2.5-9
Interrupt Selector, 2.5-9
Input, 2.5-9

Outputs, 2.5-9
Jumper, 2.5-10
Adjustments, 2.5-10

2.6 PERIPHERALS, 2.6-1
Floppy Disk Drive, 2.6-1
Display, 2.6-1
Keypad, 2.6-1
Rear Panel Interface Connectors, 2.6-1

ILLUSTRATIONS

2.1-1 Functional Diagram, 2.1-1
2.1-2 Software Menu Tree, 2.1-3

2.2-1 Top View into Upper Chassis, 2.2-3
2.2-2 Top View into Lower Chassis, 2.2-4
2.2-3 AC Power/Vacuum Relay Card, 2.2-5
2.2-4 Linear Power Supply Card, 2.2-7

2.3-1 Fluidics Panel Components, 2.3-1
2.3-2 Diluter Panel, 2.3-3
2.3-3 Probe-Wipe Traverse Assembly, 2.3-5
2.3-4 Peristaltic Pump Assembly, 2.3-5
2.3-5 Syringe Assembly, 2.3-6

2.4-1 AT Motherboard, 2.4-2
2.4-2 URA Card, 2.4-5
2.4-3 DRA Card, 2.4-8
2.4-4 Motor/Solenoid Driver Card, 2.4-12

2.5-1 Sensor Preamp Adapter Card, 2.5-3
2.5-2 Vacuum Sensor Card Block Diagram, 2.5-5
2.5-3 Vacuum Sensor Card, 2.5-6
2.5-4 SPAD Card, 2.5-10

TABLES

2.1-1 Functions the Diluter Table Can Use, 2.1-4
2.1-2 Aspiration Cycle, 2.1-5
2.1-3 Power-Up Cycle, 2.1-6

2.2-1 AT Power Supply Output Connectors, 2.2-1
2.2-2 AC Power/Vacuum Relay Card Connectors and Line Input Ranges, 2.2-6
2.2-3 Linear Power Supply Card Test Points, 2.2-8

2.3-1 Diluter Panel Solenoids and Their Function, 2.3-4
2.3-2 Peristaltic Pumps Location and Function, 2.3-6
2.3-3 Flex Connect Card Connectors and LEDs, 2.3-7
2.3-4 Solenoid Interconnect Card Connectors and LEDs, 2.3-8

2.4-1 AT Motherboard Switch and Jumper Settings, 2.4-1
2.4-2 URA Card Switch and Jumper Settings, 2.4-6
2.4-3 DRA Card Output Connectors, 2.4-7
2.4-4 DRA Card Jumper Settings, 2.4-8
2.4-5 Motor/Solenoid Driver Card Input Connections, 2.4-10
2.4-6 Motor/Solenoid Driver Card Output Connections, 2.4-10
2.4-7 Motor/Solenoid Driver Card Test Points, 2.4-11
2.4-8 Motor/Solenoid Driver Card Jumper Settings, 2.4-11

2.5-1 Sensor Preamp Adapter Card Input Connections, 2.5-1
2.5-2 Sensor Preamp Adapter Card Output Connections, 2.5-2
2.5-3 Sensor Preamp Adapter Card Jumper Settings, 2.5-2
2.5-4 Vacuum Sensor Card Test Points, 2.5-6
2.5-5 SPAD Card Input Connections, 2.5-9

2.6-1 Pinouts for Serial Ports, 2.6-1

2.1 SYSTEM OVERVIEW

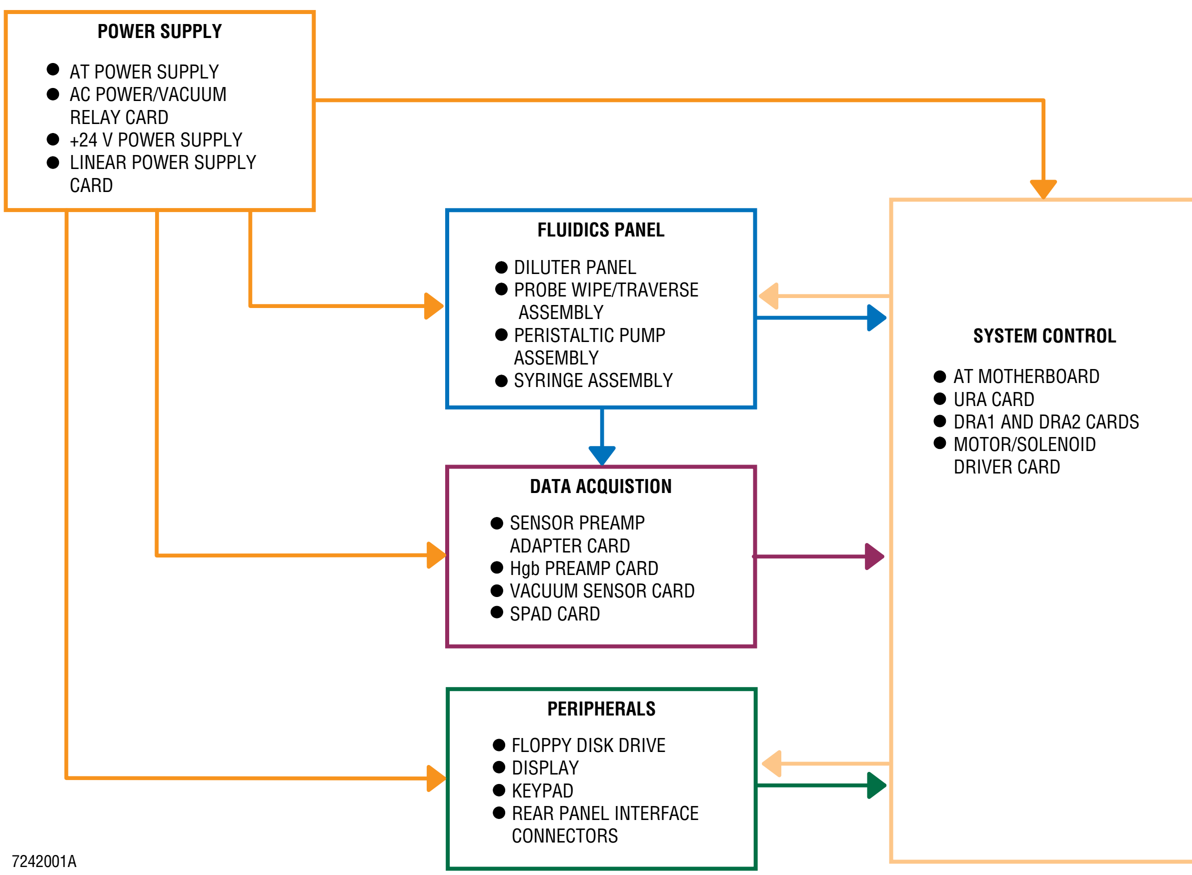
Description

The MD II instrument is an automated hematology analyzer and leukocyte differential counter For In Vitro Diagnostic Use in clinical laboratories. It is contained in one unit, with additional space needed only for the external Printer(s), the reagents, and if used, a waste container. The MD II is marketed as four distinct instruments; the 8 parameter and 10 parameter instruments which do not generate histograms, and the 16 parameter and 18 parameter instruments which do generate histograms. The 16 and 18 parameter instruments have additional hardware allowing them to generate histograms.

Since the MD II is housed in one unit with indistinct physical sections, it is easier to envision it as a set of functional or logical sections. Using this concept, the description of the unit is divided into five sections: Power Supply, System Control, Fluidics Panel, Data Acquisition and Peripherals.

See Figure 2.1-1 for a diagram of these sections and their relationships.

Figure 2.1-1 Functional Diagram



The MD II cycle begins with the presentation of a whole-blood sample to a self-washing aspirate probe. The MD II then aspirates 12 µL of blood, dilutes and analyzes the sample and makes the results available to a Liquid Crystal Display (LCD) and Printer. Instrument intelligence is provided by a program loaded at power ON from a diskette. Interaction with the instrument is largely through use of a menu system displayed on the 4-row by 40-column LCD and a numeric keypad, with select functions provided through dedicated keys.

Software Menu System

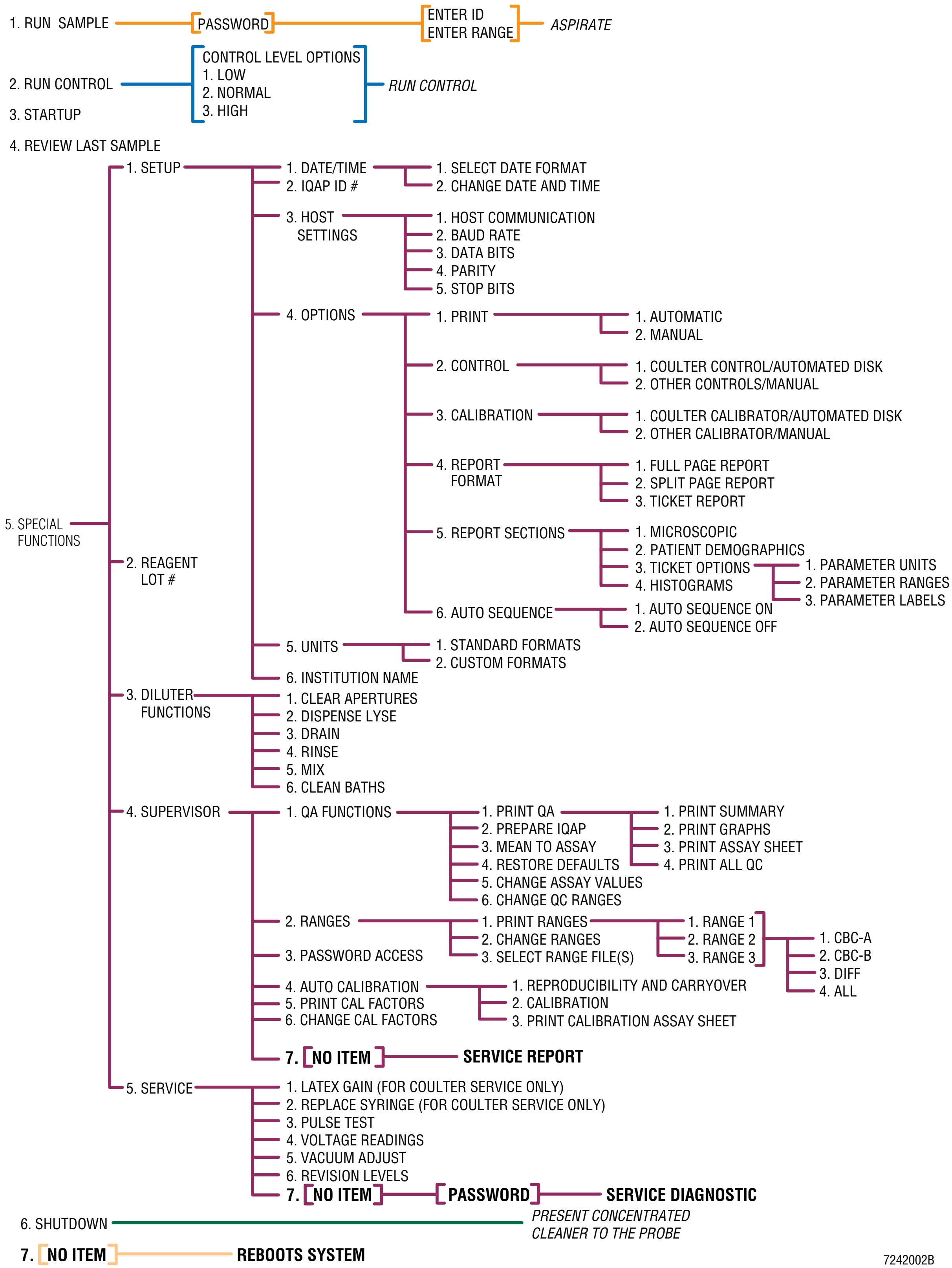
Figure 2.1-2 shows the software menu tree. This is the same menu tree that is shown and described in the customer documentation except that the three hidden menu items for service personnel are added. These hidden items, shown in bold on the diagram, are not shown on the instrument's display nor in the customer's documentation. Quick steps to access these hidden items are in Heading 4.2, ACCESSING THE HIDDEN SERVICE MENU ITEMS.

Software Tables

Instrument cycling is accomplished using diluter tables. A diluter table is a collection of software functions. The software function performs the action requested by the table, by enabling the appropriate electrical drivers. The table determines specifics, such as when to perform a certain action, and for how long. For instance, to drain a bath, a solenoid valve must be opened to open a fluid path to waste. The diluter table specifies when this valve opens and for how long. On the MD II, a peristaltic pump is used to move waste fluids. The function to turn the pump stepper motor on is given the step rate and the total number of steps. The diluter table also specifies some functions that are electronic in nature. Taking a Hgb reading and accumulating aperture data are two such functions.

This table method allows for simple changes in the diluter cycles. Since the main software does not need to be changed, only specific numbers in a specific diluter table change. All the other tables are unchanged, which would not be true if a change was made to the software function.

Figure 2.1-2 Software Menu Tree



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The MD II has seven diluter tables or cycles. These are the aspirate, power up, startup, shutdown, prime, latex and clean bath tables. Chapter 6 has timing charts for all the diluter tables. Because they are the most useful in describing and troubleshooting instrument operation, the aspirate cycle and the power-up cycle are described in detail. Make sure that you use the most recent timing chart when troubleshooting timing concerns. Table 2.1-1 gives a list of the functions that can be used by a diluter table.

Table 2.1-1 Functions the Diluter Table Can Use

Motor Functions	Solenoids & Valves	S/W Requests
Asp Syringe Fill	Vac Xdcr Vent	Read Hgb Sample
Asp Syringe Disp	Vac Chmbr Vent	Read Hgb Blank #1
Dil Srng Fil	Vac Select	Read Hgb Blank #2
Dil Syringe Disp	Sweep Flow	WBC/RBC/Plt
Probe Down	RBC Aper Vac	RBC/Plt DAQ
Probe Up	WBC Aper Vac	WBC DAQ
Probe Aspirate	Bath Drain Sel	Vacuum Offset
Probe WBC	PRB Wipe Vac	Aspirate Key Wait
Probe RBC	Air Mix Select	Delay
Mix Bubbles	Waste Select	Zap Red Aperture
Drain	Bath Rinse Sel	Zap Wht Aperture
Rinse	Bath Mix Sel	Chk Dil Snsr
Dil Rsvr Fil	Prefill Select	Wait for Enter
Dil Rsvr Overfill	Dil Prefil/Dis	Probe Warn
	Dil Srng Vlv	Dil Overfill
	Dil Dispense	Shutdown Message
	Deliver Lyse	Do CBC
	Inc. Cycle #	Do Diff
	Vacuum Pump	Print Results
	No Selection	Rpt Activity

Aspirate Table

The aspirate cycle, Table 2.1-2, is the most important table for the instrument. It is used for sample analysis during a sample, control, calibration, and reproducibility run.

Table 2.1-2 Aspiration Cycle

Time (seconds)	Activity Requested
0.0	Move aspirate probe up and turn on vacuum pump.
1.0	Read Hgb Blank #2, move aspirate probe to aspirate position, drain WBC bath and move aspirate syringes down.
2.5	Drain RBC bath and move aspirate probe down.
5.0	Display aspirate message and wait for **Aspirate** key to be pressed.
5.0	Aspirate 12 µL and rinse WBC bath.
6.0	Wipe aspirate probe while moving it up, drain WBC bath and rinse RBC bath.
8.5	Prefill WBC bath with 1.5 mL of diluent while moving aspirate probe to WBC bath.
10.0	Move aspirate probe down into WBC bath.
11.0	Take Hgb Blank #1 reading, dispense sample and diluent while draining vacuum isolator chamber (VIC).
12.0	Move aspirate probe up and mix initial WBC dilution.
14.0	Move aspirate probe down.
15.0	Aspirate 100 µL of initial WBC dilution, fill diluent reservoir, charge diluent syringe and drain RBC bath.
18.5	Move aspirate probe up.
19.5	Deliver lyse while moving aspirate probe to RBC bath and create lyse line air gap.
20.0	Move aspirate probe down while prefilling RBC bath with 0.5 mL.
21.0	Dispense RBC sample and diluent with mix bubbles.
25.0	Move aspirate probe up and apply vacuum to WBC aperture.
26.0	Apply vacuum to RBC aperture, open sweep flow and begin data accumulation.
29.0	Data accumulation takes 12 seconds with up to 24 seconds of extended count.
41.0	Turn off sweep flow and increment cycle counter.
41.5	Take Hgb readings, drain WBC bath, fill diluent reservoir and analyze data.
44.0	Rinse WBC bath, drain RBC bath, fill diluent reservoir and turn off vacuum.
46.0	Drain WBC bath, rinse RBC bath, fill diluent reservoir and begin print process.
53.0	Rinse WBC bath, drain VIC and fill diluent reservoir.
57.0	Drain VIC and overfill diluent reservoir.
60.0	Aspiration cycle is complete.

* The system extends the RBC aperture count period if there is insufficient Plt data. It uses 3-second count periods until there is sufficient Plt accumulation or a maximum of eight extra count periods have been performed.

Power-up Table

The power-up table, Table 2.1-3, is run by the instrument during its power-up process.

Table 2.1-3 Power-Up Cycle

Time (seconds)	Activity Requested
0.0	Drain WBC bath. Rinse and drain 3 times consecutively. This uses about 16 mL of diluent from reservoir.
14.0	Check diluent sensor. It should not see diluent and displays *ERROR DETECTED (017) Unable to Sense Diluent Level* if it does. Drain VIC and fill diluent reservoir to sensor.
80.0	Continue filling diluent reservoir if it is not filled to sensor.
80.0	Overfill diluent reservoir and check diluent sensor. Display *ERROR DETECTED (017) Unable to Sense Diluent Level* if no diluent is sensed. Turn on vacuum pump and drain RBC bath.
85.0	Drain probe wipe line and prefill WBC bath from diluent syringe while draining.
90.0	Request that a probe warning be displayed, and charge diluent syringe to 3.7 mL.
93.0	Force 2.5 mL of diluent through probe wipe.
97.0	Move aspirate probe up while wiping with 1.2 mL of diluent.
99.0	Move aspirate probe to aspirate position while rinsing RBC bath.
101.0	Move aspirate probe to WBC position while filling aspirate syringe.
102.0	Move aspirate probe to RBC position, then down, then up, then drain VIC. This verifies that all Probe/Wipe Traverse Assembly position sensors are working.
107.0	Move aspirate probe down, home aspirate syringe, move aspirate probe up.
115.0	Fill diluent syringe with 4 mL of diluent and aspirate syringe with 50 µL of diluent while draining RBC bath.
118.0	Wash aspirate probe as it moves down, dispense 50 µL of diluent from aspirate syringe, drain RBC bath.
123.0	Move aspirate probe up, charge diluent syringe to 4 mL, fill diluent reservoir.
128.0	Drain WBC bath while prefilling with 2 mL of diluent, then drain RBC bath while prefilling with 1 mL of diluent. This primes prefill tubing.
132.0	Fill diluent syringe with 1.2 mL of diluent while moving probe down. Wash aspirate probe as it moves up, while also draining WBC bath.
136.0	Drain VIC, apply mixing bubbles while rinsing WBC bath, drain WBC bath.
140.0	Fill diluent reservoir, then rinse RBC bath while applying mixing bubbles. Drain RBC bath and fill diluent reservoir.
145.0	Rinse WBC bath, fill diluent reservoir, rinse RBC bath, fill diluent reservoir.
156.0	Open up aperture count and sweep-flow lines. Prime for 25 seconds.
181.0	Close RBC aperture count and sweep-flow lines. Continue priming WBC aperture module for 25 seconds
206.0	Drain VIC, turn off vacuum pump and fill diluent reservoir.
211.0	Drain WBC bath.
213.0	Rinse WBC bath, drain RBC bath, then fill diluent reservoir.
217.0	Zap apertures for 1 second and fill diluent reservoir.
228.0	Power-up cycle is complete.

2.2 POWER SUPPLY

Overview

Ac is input into the lower chassis using a connector that is also a line filter. Both lines are fused, F1 on the hot line and F2 on the neutral line. For 120 Vac units, a 4.0-A SLO-BLO fuse is used, and for 220 Vac units a 2.0-A SLO-BLO fuse is used. Additional conditioning is provided by the Transient Voltage Suppressor card, a simple circuit card comprised of a gas tube surge arrester and three varistors, connected in parallel to the incoming ac line. The ac voltage is then made available to the AC Power/Vacuum Relay card and the AT power supply, a PC-type computer switching supply in the upper chassis.

System power is turned on using the switch built into the AT power supply. This provides ±5 V and ±12 V to the computer in the upper chassis and any cards using the computer bus. The User Resource Adapter (URA) card routes +5 V from the AT motherboard to the LCD screen resulting in two solid bars being displayed. System software controls the display, so no further screen image is seen until the system software is loaded from the Program Disk and is executed.

Connector P2 of the AT power supply also provides +12 V directly to the AC Power/Vacuum Relay card, energizing relay K2 and routing ac to transformer T1 and the +24 V switching power supply. Three transformer secondary voltages provide input ac to the Linear Power Supply card, which immediately makes available ±15 Vdc, aperture and aperture zap voltages and the Hgb LED (Light Emitting Diode) current. When the system software has been loaded and is in control, the Diluter Resource Adapter (DRA) card sends a command to the Motor/Solenoid Driver card to turn on the +24 V.

AT Power Supply

The AT power supply is found in the upper chassis (see Figure 2.2-1) and is a PC-type, 200-W, switching power supply, providing ±5 V and ±12 V (Table 2.2-1). It has a built-in cooling fan that provides air flow to the upper chassis area. Its Power On/Off switch also serves as the instrument's Power ON/OFF switch.

The power supply is purchased as a unit and should be replaced as a unit. Schematics and component parts are not available.

Inputs

Standard ac line cable input connector

Outputs

Table 2.2-1 AT Power Supply Output Connectors

Connector	Type	Volts Supplied	Description
P1	Low-power utility	+5, +12	1.0 A
P2, P3	High-power utility	+5 +12	1.8 A 2.8 A
P4, P5	AT power supply	±5, ±12	To AT motherboard

Switches

- Power On/Off switch - used as instrument's Power ON/OFF switch
- Ac Select switch - selects 115 or 230 Vac supply (not accessible when in unit)

AC Power/Vacuum Relay Card

The AC Power/Vacuum Relay card is found in the lower chassis (Figure 2.2-2) and takes the ac input and distributes it. The card receives ac directly from line input and directs it for system use. Ac into the card is first sent through relay K2. This relay directs ac to the voltage selector plug when it is energized by +12 V, input from the AT power supply in the upper chassis. The ac is then directed to transformer T1 for use by the Linear Power Supply card, to the +24 V power supply, and to solid state relay K1. The ac hot (black) line to relay K1 is sent through fuse F1, a 0.4-A, 250-V SLO-BLO fuse. A VAC ON signal of +24 V energizes K1, which provides ac to the vacuum pump, (shown on Figure 2.2-2), turning it on.

The input and output connectors and test points are shown on Figure 2.2-3 and the line input ranges are summarized on Table 2.2-2, at the end of this section.

Figure 2.2-1 Top View into Upper Chassis

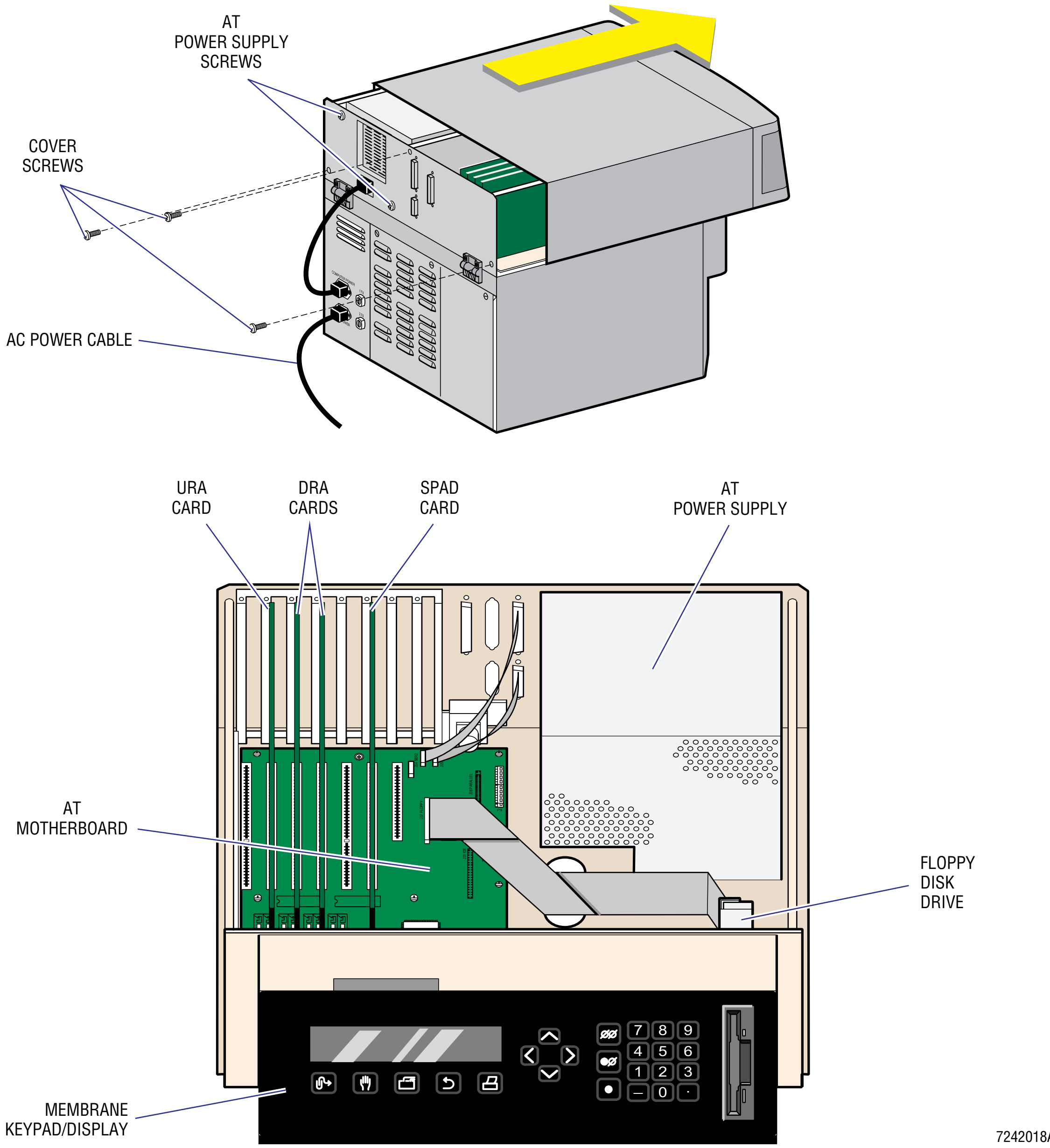


Figure 2.2-2 Top View into Lower Chassis

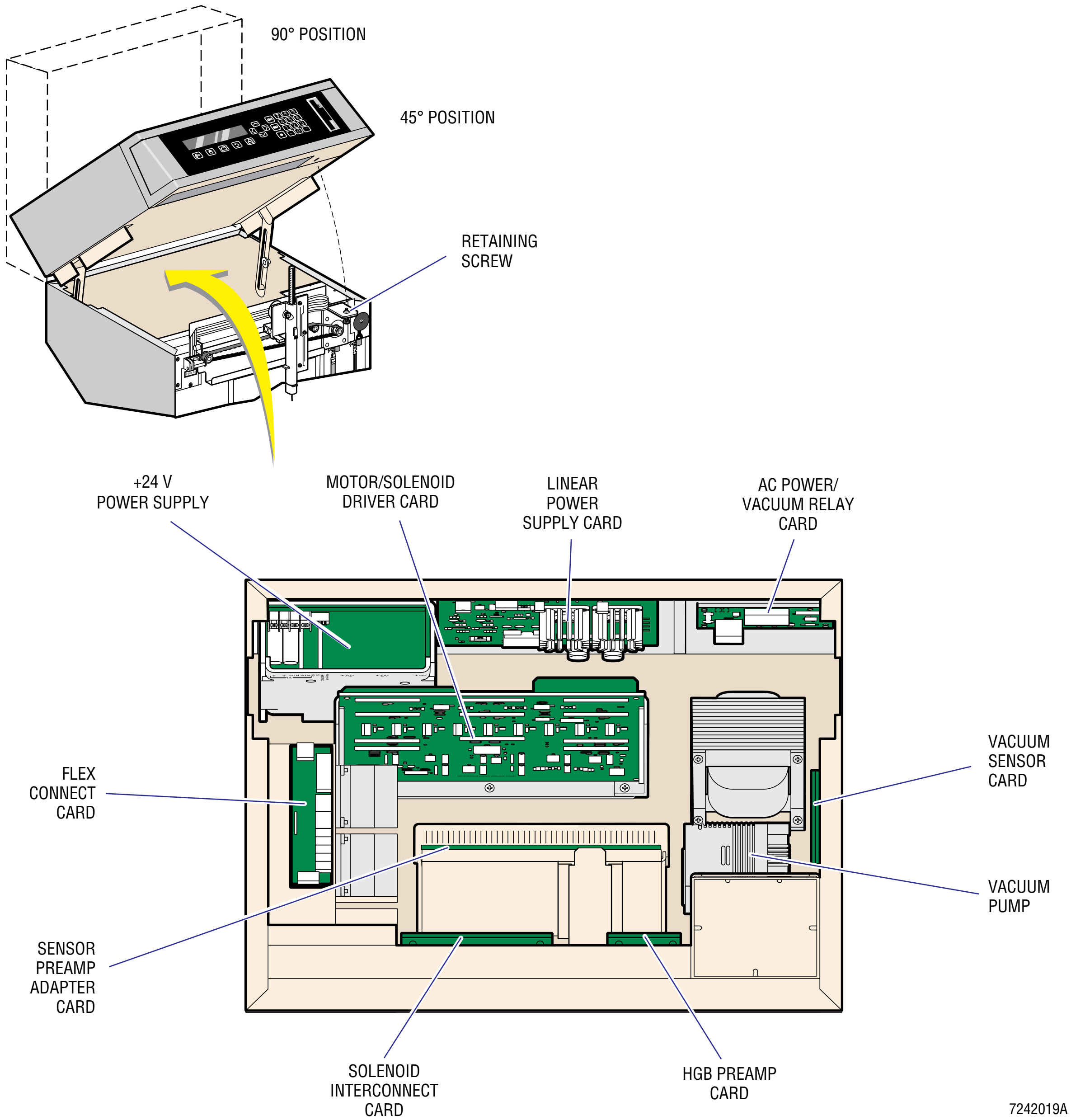
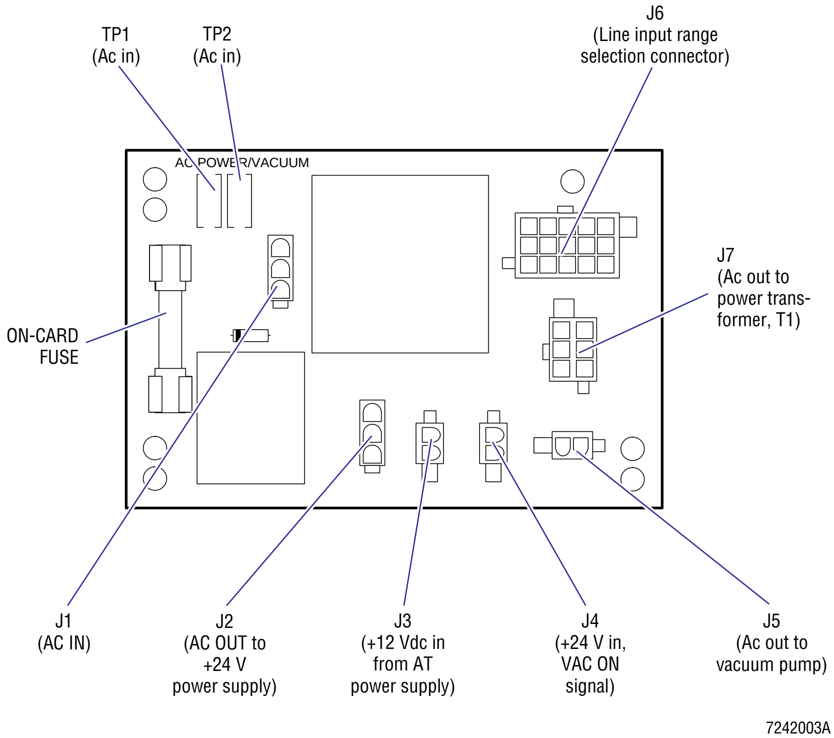


Figure 2.2-3 AC Power/Vacuum Relay Card



Inputs

- J1 - AC IN
- J3 - +12 Vdc from AT power supply (PWR ON)
- J4 - +24 V, VAC ON signal

Outputs

- J2 - AC OUT TO +24 V
- J5 - ac out to vacuum pump (VACUUM)
- J7 - ac out to power transformer, T1

Test Points

TP1, TP2 - ac in

Jumpers

J6 is a selection jumper connector that selects between the four possible line input ranges (Table 2.2-2).

Table 2.2-2 AC Power/Vacuum Relay Card Connectors and Line Input Ranges

Connector	Line Input Range
100 VOLTS	90 - 110 Vac
120 VOLTS	110 - 132 Vac
220 VOLTS	198 - 242 Vac
240 VOLTS	220 - 264 Vac

There are four plugs available to select the appropriate range. Though units are sold for a specific power range, the other three plugs are available if the power does not match with the plug being used.

+24 Volt Switching Power Supply

The +24 V power supply (Figure 2.2-2) is a switching power supply with a minimum frequency of 100 kHz and a maximum rated output of 6 A at 24 Vdc. It senses and automatically adjusts for 120 or 220 Vac input. Internal protection includes a 6.3-A fuse for ac input, output voltage clamped at 30% overvoltage, and automatic shutdown for an overtemperature condition.

The POWERFAIL (PF/PG) signal at J1 is monitored by the MD II. This is a TTL-compatible signal referenced to the negative sense line at J1. A logical low indicates a fault condition and is generated by a thermal shutdown or an ac failure longer than 38 ms.

The +24 V power supply is purchased as a unit. If it has problems, it should be replaced as a unit, not repaired. Schematics and component parts are not available.

Inputs

- TB1 - 90 - 264 Vac, 47 - 63 Hz
- J1 - ON/OFF signal to turn supply ON

Outputs

- TB2 - +24 Vdc
- J1 - POWERFAIL (PF/PG) signal, internal regulator sense lines

Adjustments

V1 - This is set at the factory. Do not adjust.

Linear Power Supply Card

The Linear Power Supply card (see Figure 2.2-2 for location) provides voltages not supplied by the AT power supply or +24 V power supply. Three ac voltages are supplied to the Linear Power Supply card: 18.5, -18.5 and 165 Vrms (voltage root mean square). The white/orange wires connected to J1-2 and J1-5 supply 18.5 Vrms. This is applied to bridge rectifier VR2, producing an unregulated +25 Vdc. A regulator using an LM7815CK (U5) regulator circuit produces the +15 V output from the card. This +15 V is also used onboard by regulator circuit U4 to produce a 2.5-V supply that provides a constant current source for the Hgb LED.

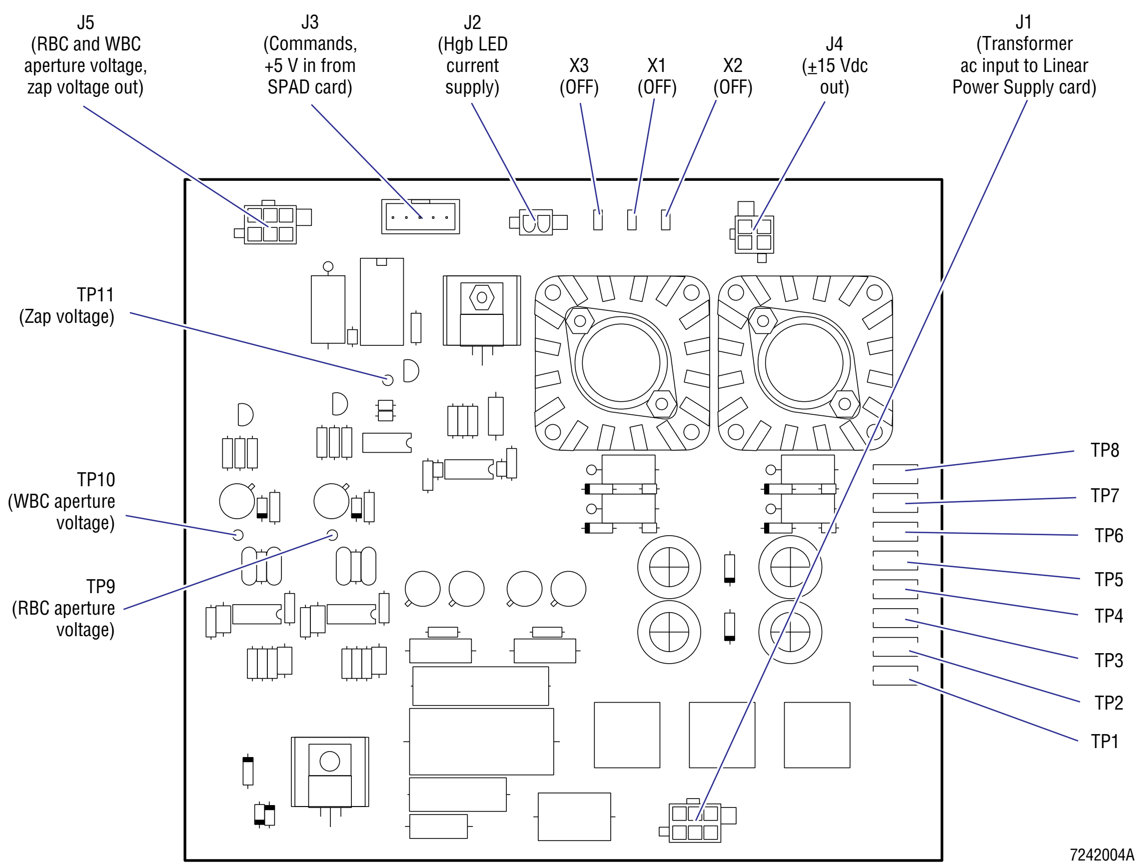
The white/green wires connected to J1-1 and J1-4 supply -18.5 Vrms to bridge rectifier VR3. This produces an unregulated -25 Vdc that is regulated using an LM7915CK (U6) regulator circuit. The output of this regulator circuit is the Linear Power Supply card -15 Vdc output.

The red wire pair connected through J1-3 and J1-6 provide 165 Vrms for the aperture supply voltages. Bridge rectifier VR1 produces about +240 Vdc from this supply. This +240 V is used by three circuits. It is regulated to +200 V by one circuit and used for the aperture burn or zap voltage. A CLEAR APERTURE command from the Sensor Processing Adapter with Diagnostics (SPAD) card, entering the Linear Power Supply card at J3-8 or J3-10 (these pins are tied together on the card), enables relay K1, which outputs the zap voltage to the apertures. The +240 V is also used to produce the Red and White Aperture Voltage circuits. These circuits receive gain control from the SPAD card, the red aperture current control from pin J3-6, and the white aperture current control from pin J3-5. Performing the Latex Gain Adjustment procedure (Heading 4.27) sets this gain.

A RED APERTURE ON command at pin J3-7, and a WHITE APERTURE ON command at J3-4, both from the SPAD card, direct the output voltages to their respective apertures at the appropriate time.

Test points for the Linear Power Supply card are summarized in Table 2.2-3, at the end of this section. Figure 2.2-4 shows the location of the test points, the location and setting of the jumpers and the location of the input and output connectors.

Figure 2.2-4 Linear Power Supply Card



Inputs

- J1 - Transformer ac input to Linear Power Supply card
- J3 - commands, +5 V from SPAD card

Outputs

- J2 - Hgb LED
- J4 - ±15 Vdc
- J5 - RBC aperture voltage, WBC aperture voltage, and zap aperture voltage

Test Points

Table 2.2-3 Linear Power Supply Card Test Points

Test Point	Supply
TP1	+240 Vdc ground
TP2	+240 Vdc
TP3	-15 Vdc ground
TP4	-15 Vdc
TP5	+15 Vdc ground
TP6	+15 Vdc
TP7	Hgb LED cathode (negative lead)
TP8	Hgb LED anode (positive lead)
TP9	RBC aperture voltage
TP10	WBC aperture voltage
TP11	Aperture zap voltage (200 V)

Jumpers

X1 (GND1), X2 (GND2), X3 - These jumpers should be OFF for instrument operation. See Figure 2.2-4 for location. They are used to provide grounding for testing the card outside of the unit. Normal system connection provides grounding through the Sensor Preamp Adapter card.

2.3 FLUIDICS PANEL

Overview

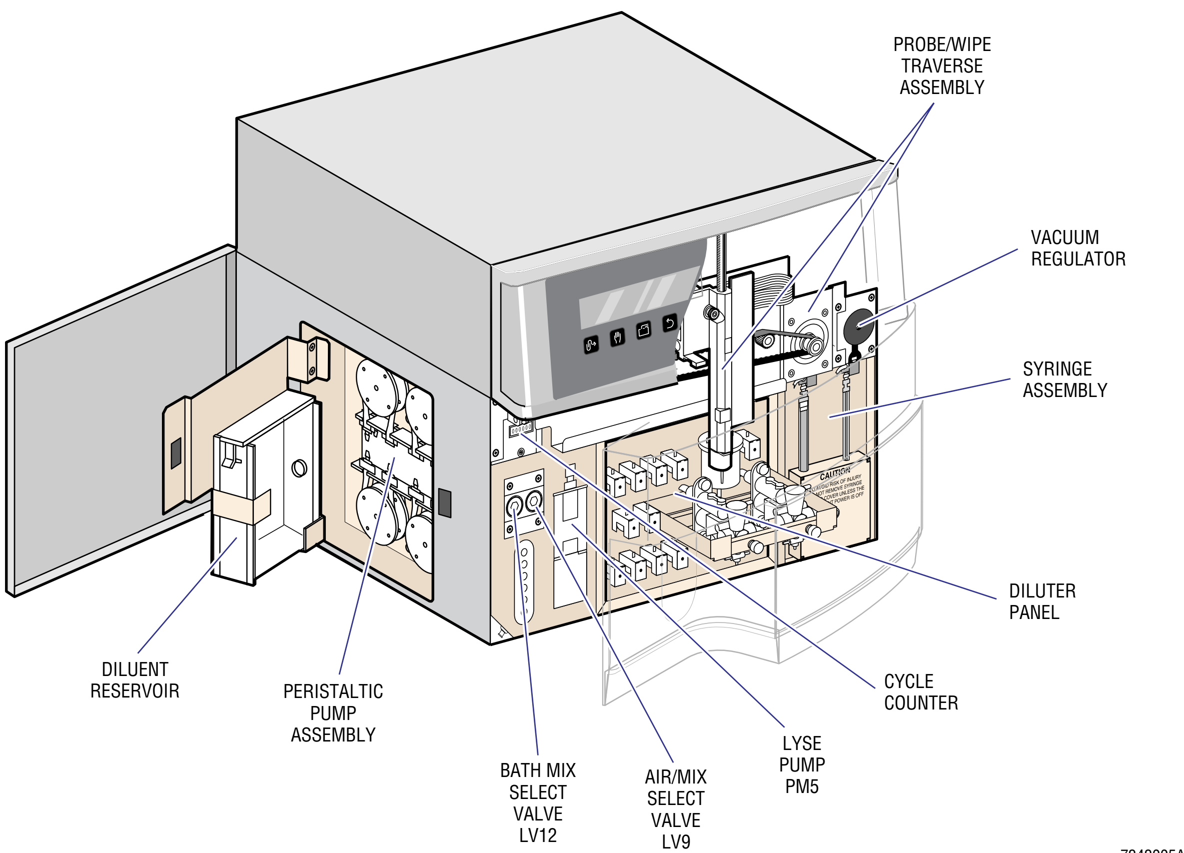
The Fluidics Panel is responsible for receiving, preparing and presenting the sample for electronic analysis, and preparing for introduction of the next sample.

Whole-blood sample is aspirated through a sample aspirate probe, then transported to the counting chambers. This is accomplished by the Probe/Wipe Traverse Assembly. A self-washing mechanism is built into this assembly, relieving the operator of having to wipe the probe.

Precision dilutions are accomplished using two syringes that make up the Syringe Assembly. Fluidic operations requiring less precision, such as rinsing and draining, are accomplished using peristaltic pumps. The peristaltic pumps make up the Peristaltic Pump Assembly. The baths and the fluidic solenoids, controlling most of the fluidic activity are mounted on the Diluter Panel. Several individual components that complete the diluter are mounted directly to the Fluidics Panel.

The Diluter Panel, Probe/Wipe Traverse Assembly, Peristaltic Pump Assembly, Syringe Assembly and several individual components are mounted to the Fluidics Panel (Figure 2.3-1).

Figure 2.3-1 Fluidics Panel Components



Diluter Panel

The Diluter Panel is located in the lower front of the instrument and is the main fluidic module of the MD II. It holds all the fluid solenoid valves, the VIC, the sweep-flow tubing, the aperture and bath components, and the Hgb LED and detector. See Figure 2.3-2. The Sensor Preamp Adapter card is also attached to the back of the Diluter Panel through the Aperture Electrode module cable shield. This shield provides grounding for the Diluter Panel through the Sensor Preamp Adapter card. The Diluter Panel itself is isolated from the chassis.

The aperture system is made up of an open sample bath with an external ground electrode, an Internal Electrode module and an aperture block that fits into the Internal Electrode module. There are two aperture systems, one for the WBC dilution and one for the RBC/Plt dilution.

The WBC side has a 100-µ aperture similar to other COULTER instruments, except that the aperture has been reversed to make a flatter external surface. This is done to minimize carryover in the WBC bath. The RBC bath uses a 50-µ aperture. There is one difference in the way these components are used in the MD II from other COULTER systems. The outside or shield conductor of the external electrode coaxial cable is used for the signal return path. The external or ground electrode from the bath is connected to this conductor and is fed to the Sensor Preamp Adapter card inside a metal shield.

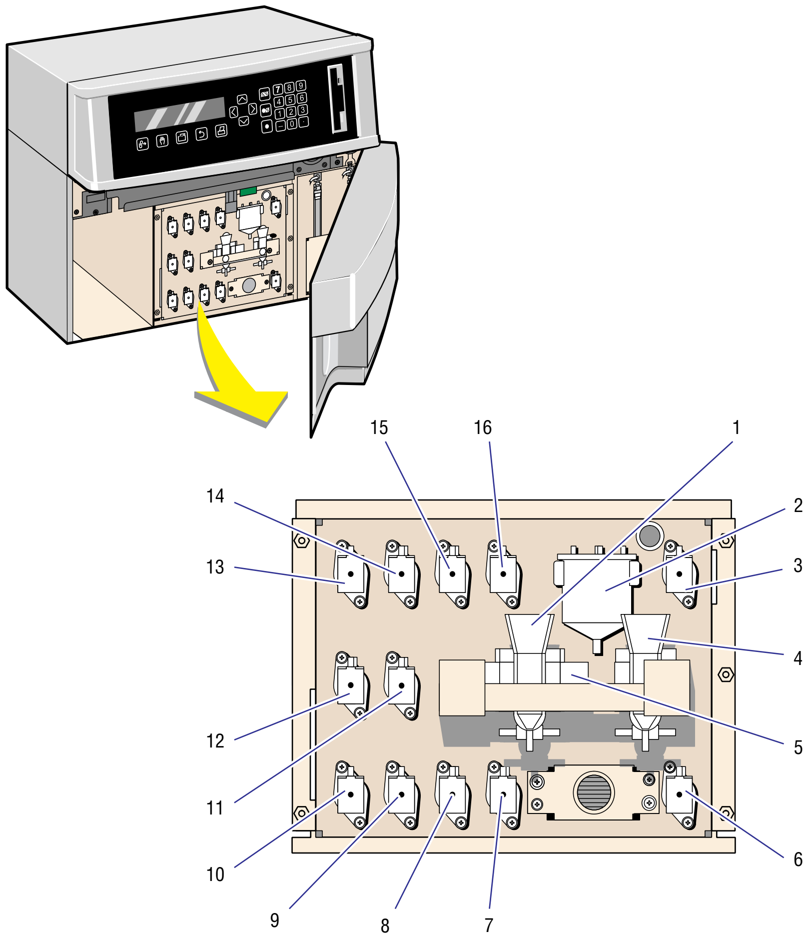
Hgb components are mounted directly to the WBC bath. There is an LED to supply light for the colorimetric measuring system. It is supplied with a low constant current source and does not generate very much heat. The light emitted from the LED is sent through a 525-nm filter. A photodetector is mounted on the other side of the bath. The output from this detector is sent to the Hgb Preamp inside the lower chassis.

A sweep-flow system is used by the RBC aperture to sweep red cells from the sensing zone after they have passed through the aperture. The sweep-flow tubing is housed on a spool that rests in a cavity below and between the baths. The cavity provides shielding, so no elaborate canister or isolation grounding system is needed. Sweep flow on the MD II uses 13 ft of tubing. This is possible because the diluent source is from a vented reservoir in the instrument and independent of external reagent location.

As with other COULTER instrumentation, a VIC is used to provide constant vacuum to both apertures while electrically isolating the electrolytic fluids drawn through the apertures. This count vacuum is regulated at 6 in. Hg, and the vacuum sensor is directly connected to the VIC, reducing the possiblility of inaccurate count vacuum.

The VIC is also used as a waste reservoir for the probe wipe. Raw pump vacuum of about 15 in. Hg is applied to the chamber for use by the probe wipe mechanism. How the VIC is tubed is very important. The probe wipe produces a great deal of splashing which causes salt bridges, eliminating the electrical isolation for the apertures. There are splash guards inside the VIC to prevent splashing from the outside ports and the probe wipe waste should enter these outside ports.

Figure 2.3-2 Diluter Panel



1. WBC BATH/APERTURE
2. VACUUM ISOLATOR CHAMBER
3. RBC VACUUM VALVE (LV5)
4. RBC BATH/APERTURE
5. Hgb LED
6. RINSE VALVE (LV11)
7. DRAIN VALVE (LV7)
8. PREFILL VALVE (LV13)
9. SWEEP FLOW VALVE (LV4)
10. WASTE VALVE (LV10)
11. DISPENSE/PREFILL VALVE (LV14)
12. DILUENT DISPENSE VALVE (LV16)
13. PROBE WIPE VALVE (LV8)
14. DILUENT FILL VALVE (LV15)
15. VACUUM LOW/HIGH VALVE (LV3)
16. WBC VACUUM VALVE (LV6)

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Solenoids provide the fluidic logic for the MD II. There are 12 fluidic solenoids mounted on the Diluter Panel (Figure 2.3-2). Table 2.3-1 lists these solenoids, their name, type and function.

Table 2.3-1 Diluter Panel Solenoids and Their Function

Solenoid	Name	Type	Function
LV3	Vac Select	3-way	Selects regulated or raw pump vacuum for the VIC.
LV4	Sweep Flow	2-way	Opens the diluent path for sweep flow.
LV5	RBC Aper Vac	2-way	Opens the RBC aperture count path to the VIC.
LV6	WBC Aper Vac	2-way	Opens the WBC aperture count path to the VIC.
LV7	Bath Drain Sel	3-way	Selects which bath drains.
LV8	PRB Wipe Vac	2-way	Opens a path from the VIC to the probe wipe housing to evacuate fluids with high vacuum.
LV10	Waste Select	3-way	Selects whether one of the baths drains or the VIC drains.
LV11	Bath Rinse Sel	3-way	Selects which bath receives rinse from PM3.
LV13	Prefill Select	3-way	Selects which bath gets prefill from the diluent syringe.
LV14	Dil Prefil/Disp	3-way	Selects whether diluent from the diluent syringe is used for prefill or the dispense selection of LV16.
LV15	Dil Srng Fil	3-way	Switches between the diluent reservoir for diluent syringe input and LV14 for diluent dispense output.
LV16	Dil Dispense	3-way	Switches diluent dispense between the probe wipe housing and the aspirate probe via the aspirate syringe.

Probe/Wipe Traverse Assembly

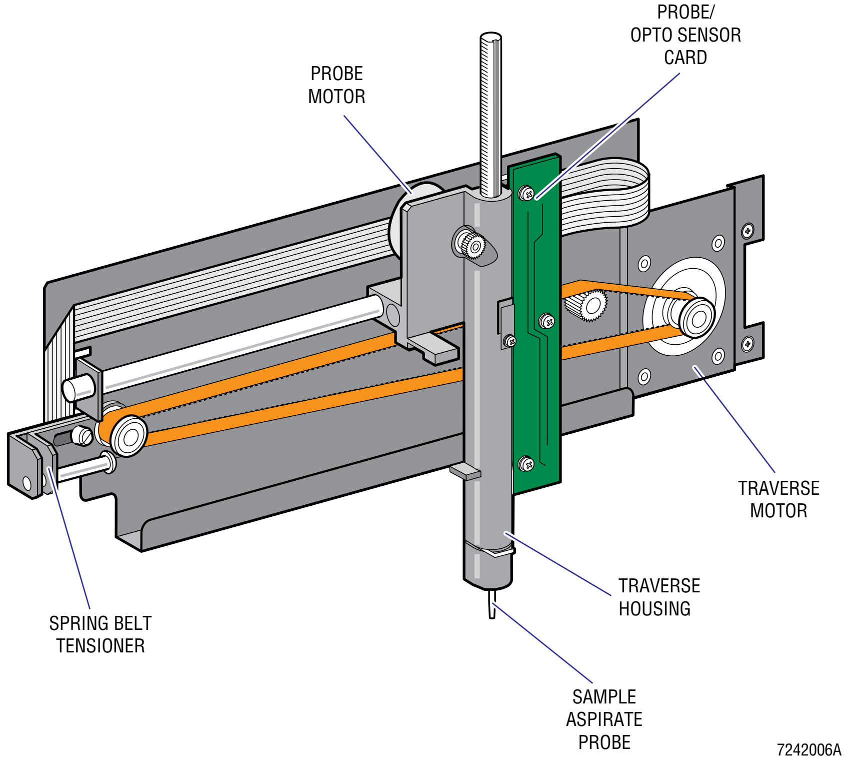
The Probe/Wipe Traverse Assembly is located on the upper front of the instrument (Figure 2.3-1) and is responsible for presenting the probe for whole-blood aspiration, washing the probe after aspiration, and moving whole blood and diluted sample to the appropriate bath.

Vertical movement is provided by a small stepper motor, the probe motor, mounted to the traverse housing. See Figure 2.3-3. Control is provided using two optical sensors mounted on the Probe/Opto Sensor card.

As the probe is moved up and down, it travels through the wipe housing. The wipe housing has two ports, one with high vacuum applied, another attached to the diluent syringe. After aspiration, as the probe is moving up, fluid is forced through the housing by the diluent syringe as vacuum is applied. This washes the probe exterior. At several other instances of instrument operation, with the probe moving up or down, vacuum alone is applied to dry the probe and ensure that no dripping occurs.

Horizontal movement is provided by the traverse motor, a larger stepper motor using a belt drive. The entire probe and probe wipe mechanism is moved as a unit to each station. This eliminates many alignments and adjustments, producing a simple and reliable mechanism. The only adjustment on the assembly is the spring belt tensioner for the horizontal drive belt. This tensioner is designed in such a way that it does not need readjustment even when the belt is replaced.

Figure 2.3-3 Probe-Wipe Traverse Assembly



Peristaltic Pump Assembly

The Peristaltic Pump Assembly is located on the lower left side of the instrument and consists of a plate holding four peristaltic pumps and their associated tubing. See Figure 2.3-4. Table 2.3-2 gives each pump's location and function. The green and blue filters are also found on this assembly. The green filter, a 0.45-µ fluid barrier, is found in the air lines. It blocks fluid that might get into the line, from going any further. The blue filter, a 10-µ filter, is in the fluid lines. The blue filter blocks particulate and air bubbles.

Figure 2.3-4 Peristaltic Pump Assembly

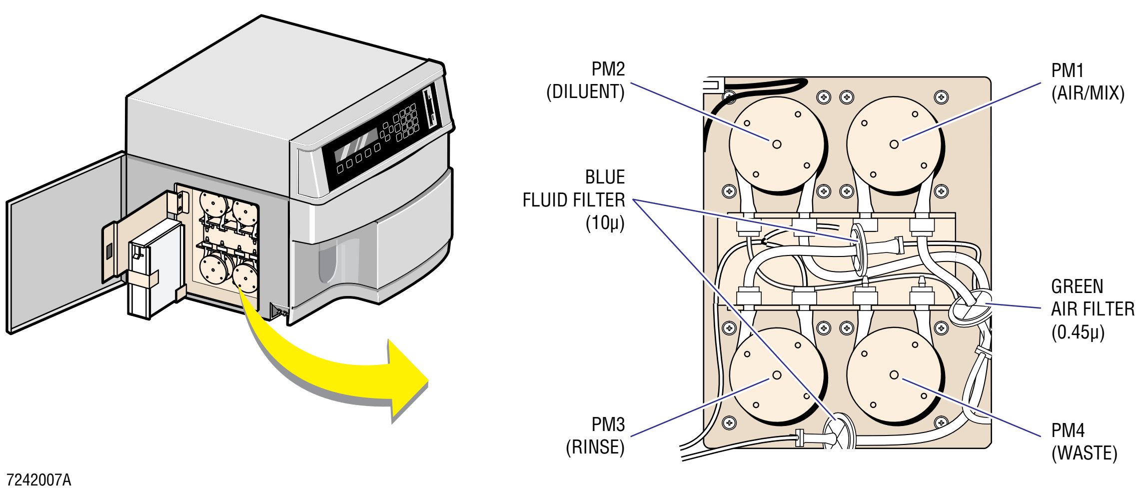


Table 2.3-2 Peristaltic Pumps Location and Function

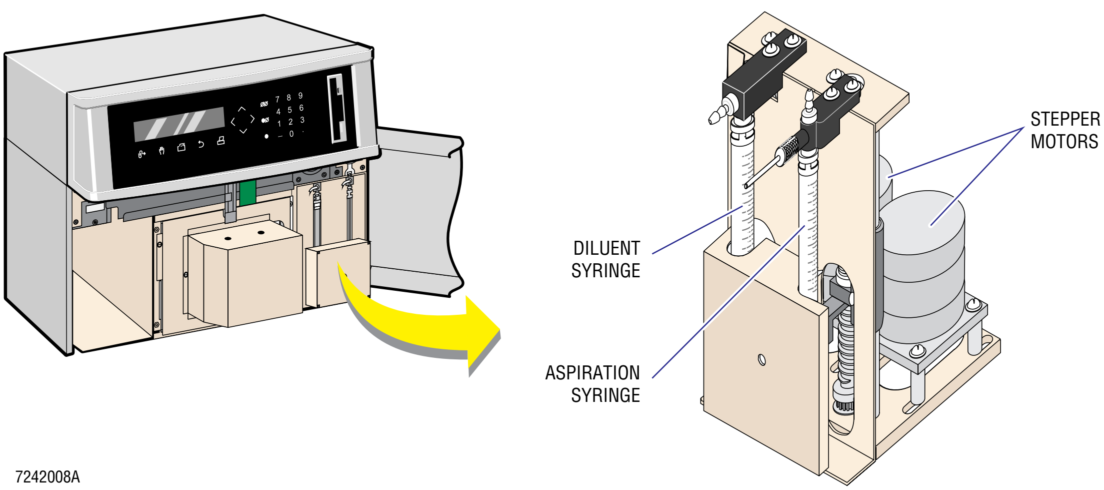
Pump	Location	Function
PM1 (Air/Mix)	Upper right	Provides air for isolation and mixing bubbles.
PM2 (Diluent)	Upper left	Fills the diluent reservoir from the diluent tube.
PM3 (Rinse)	Lower left	Rinses the baths with fluid from the diluent reservoir.
PM4 (Waste)	Lower right	Drains the VIC and both red and white baths.

Syringe Assembly

The Syringe Assembly is located on the right front of the instrument and consists of two identical syringe drives with different syringe bodies. See Figure 2.3-5. Both are driven with the same type of stepper motor that is used by the Probe/Wipe Traverse Assembly and the Peristaltic Pump Assembly. Motion is accomplished using a belt-driven lead screw. The lead-screw assembly, purchased as a component, is comprised of the lead screw, lead-screw housing and backlash spring.

The left syringe drive has a 5-mL syringe mounted to it and is used for supplying diluent to the count dilutions. A 100-µL syringe is used for sample aspiration and RBC aspiration. Input and output control is the responsibility of solenoid valves LV14, LV15, and LV16, mounted on the Diluter Panel.

Figure 2.3-5 Syringe Assembly



Individual Components Mounted to Fluidics Panel

The following individual components are mounted directly on the Fluidics Panel:

- Cycle counter and air solenoids
- Diluent reservoir
- Flex Connect card
- Lyse pump (PM5
- Solenoid Interconnect card
- Vacuum regulator.

Cycle Counter and Air Solenoids

The front left portion of the lower chassis houses the cycle counter, solenoids LV9 and LV12, and the lyse pump PM5 (Figure 2.3-1).

Solenoids LV9 and LV12 control the air pumped from peristaltic pump PM1. LV9 selects which bath gets mixing bubbles and LV12 routes air for the lyse line air gap.

Diluent Reservoir

The diluent reservoir is located on the left side of the instrument. See Figure 2.3-1. This is a diluent tank into which diluent from the external source is pulled and temporarily stored. Having a diluent reservoir in the instrument minimizes the effect of diluent height, especially for the RBC aperture sweep flow, and the need to prime diluent after the instrument has been sitting for a while. An added bonus is that any bubbles pulled into the reservoir from the external diluent system dissipate in the reservoir and are not pulled into the diluter. The reservoir has its own optical sensor, used to control the fluid level in the reservoir.

Flex Connect Card

The Flex Connect card is located in the lower chassis (Figure 2.2-2) and serves the same interface function as the Solenoid Interconnect card. It provides a convenient connector location for additional Fluidics Panel components and also provides an LED power indicator for several of them.

The most prominent connector is J1, the flex cable from the Probe/Wipe Traverse Assembly. This cable has the up and down probe sensor and probe motor wires. Table 2.3-3 shows the various connectors and their association.

Table 2.3-3 Flex Connect Card Connectors and LEDs

Connector	Component	LED
J1	Flex cable	No LED
J2	Out to Motor/Solenoid Driver card	No LED
J3	S10 - Waste sensor	No LED
J4	S9 - Lyse sensor	No LED
J5	S8 - Diluent sensor	No LED
J6	LV9 - Air/Mix Select solenoid	CR1
J7	LV12 - Bath Mix Select solenoid	CR2
J8	Vacuum pump	CR3
J9	Cycle counter	CR4
J10	Lyse pump	CR5

Lyse Pump (PM5)

The lyse pump (Figure 2.3-1) is a solenoid pump with a spring return. Several specifications of this pump should be considered when troubleshooting the lyse system. It has an adjustable working range of 200 to 450 µL and should be set to 415 ±5 µL. It cannot be energized for more than 6 seconds or damage will result. The MD II energizes the lyse pump for 300 ms whenever it dispenses lyse and has a fail-safe that cuts power after 1 second.

Internal sealing is accomplished using both O-rings and diaphragms. To leak back to the lyse container, reverse pressure would have to pull through a spring pressured O-ring seal and a diaphragm seal, similar in action, to a check valve. Forward pressure opens the diaphragm seal by design, just as forward pressure causes flow through a check valve. Forward pressure would also push against the spring, weakening the O-ring seal. For this reason, the pump is rated at only 6 in. of positive pressure meaning the lyse container cannot be greater than 6 in. above the pump.

Solenoid Interconnect Card

The Solenoid Interconnect card is located in the lower chassis (Figure 2.2-2) and provides an interface for wiring the Diluter Panel solenoids and the horizontal probe position sensors in a convenient location.

To facilitate servicing the instrument, LEDs were added to each solenoid line. A lit LED indicates that its associated solenoid is being energized by the system. See Table 2.3-4 for connector and LED associations.

Table 2.3-4 Solenoid Interconnect Card Connectors and LEDs

Connector	Solenoid or Sensor	LED
J1	LV6	CR1
J2	LV7	CR2
J3	LV11	CR3
J4	LV10	CR4
J5	LV3	CR5
J6	LV13	CR6
J7	LV4	CR7
J8	LV14	CR8
J9	LV8	CR9
J10	LV16	CR10
J11	LV5	CR11
J12	LV15	CR12
J13	LV2 (on Vacuum Sensor card)	CR13
J14	LV1 (on Vacuum Sensor card)	CR14
J15	S1 (WHT position)	No LED
J16	S2 (RED position)	No LED
J17	S3 (ASP position)	No LED
J18	Spare	No LED
J19	Out to Motor/Solenoid Driver card	No LED

Vacuum Regulator

The vacuum regulator (Figure 2.3-1) is a solid-state regulator used to regulate the 6-in. Hg count vacuum. It is located in the upper right area of the front panel and is accessible to customers for adjustment.

2.4 SYSTEM CONTROL

System control is the heart of the instrument. The components that form system control translate executing programs (software) into mechanical actions. The cards responsible for system control are the: AT motherboard, URA, DRAs and Motor/Solenoid Driver.

AT Motherboard

The motherboard is located in the upper chassis (Figure 2.2-1) and is the primary control in the system. It is a standard AT motherboard, using an 80386, 20-MHz CPU. BIOS is AMIBIOS with a custom default configuration for Coulter. This ensures that the BIOS configuration defaults to the instrument configuration if battery backup power is lost.

The motherboard's serial and Printer connectors and the floppy disk drive controller are used for the instrument input/output.The four Coulter system cards (URA, DRA1, DRA2 and SPAD) are plugged into the 16-bit motherboard slots.

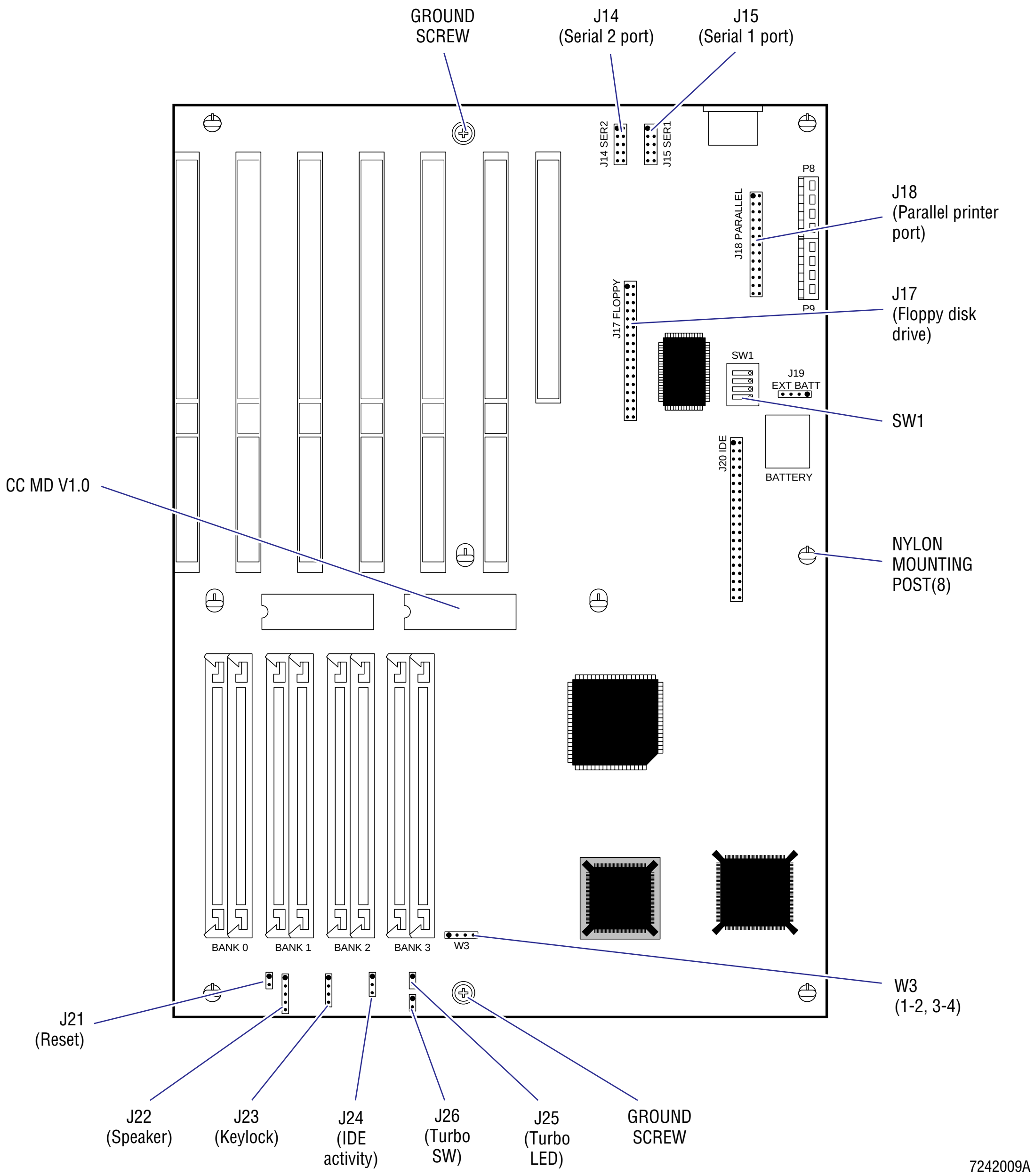
The motherboard's switches and jumpers are summarized in Table 2.4-1 and Figure 2.4-1 shows the locations of the switches, jumpers and connectors.

Switches and Jumpers

Table 2.4-1 AT Motherboard Switch and Jumper Settings

Switch or Jumper	Description	MD II Setting
SW1-1	ON - Use on-board battery OFF - Use off-board battery	ON
SW1-2	ON - Enable battery OFF - Disable battery	ON
SW1-3	ON - Additional wait states for IDE interface OFF - No additional wait states	OFF
SW1-4	ON - Color adapter OFF - Monochrome adapter (does not matter when using EGA or VGA)	OFF
W3 (Jumper)	1 to 2, 3 to 4 - 256 K or 1 MB SIMMS 2 to 3 - 4 MB SIMMS	1 to 2, 3 to 4

Figure 2.4-1 AT Motherboard



User Resource Adapter (URA) Card

The URA card is located in the upper chassis (Figure 2.2-1) and its main responsibility is to interface the system software with user resources, specifically the keypad and the display. In addition to various support circuits, the URA card also has non-volatile CMOS RAM, a Data Acquisition circuit and a Utility Timer circuit.

Switch and jumper settings are summarized on Table 2.4-2, Figure 2.4-2 shows the location of the connectors, switches and jumper in addition to the jumper setting. Table 2.4-2 and Figure 2.4-2 are at the end of the description of the URA card.

Keypad Controller

The heart of the keypad controller is an 8279 keyboard controller chip. This chip is operated in "scan keyboard" mode. The keypad is a standard row and column matrix, and with the help of an HC138 decoder used to decode the rows, the keypad controller is able to sense any pressed keys. Communication with the keypad is through J5 (Figure 2.4-2), a 20-pin in-line connector that receives the flex cable connector from the keypad.

Display Controller

The display controller is made up of a connector for the display, an 8-bit buffer, a programmable logic device or GAL, and a Display Contrast circuit. The connector, J4 (Figure 2.4-2), provides the display with its data bus, command functions, power and a contrast setting. Data is provided directly from the CPU. The GAL provides each of the eight display command functions its own port, enabling the CPU to control the display. Two voltages are provided for the display, +5 V for power and a variable supply to control display contrast. Display contrast can be adjusted with R5.

The display control logic (GAL) provides support for the options switch function. By addressing a GAL port, the CPU can read the eight-position options switch, providing a read-only port with up to 256-coded combinations.

CMOS RAM

The URA card provides a single chip of CMOS static RAM (Figure 2.4-2). This RAM chip has an internal battery and power management circuitry, making it non-volatile. A programmable logic GAL is used to control this chip.

The instrument uses this memory to store all user system settings, like aperture current voltages, print formats, calibration factors and host interface settings. The data in RAM is actually an image of a file on the Program Disk named PD.DAT. A new Program Disk contains default settings and if there is no data in memory, the PD.DAT file is stored in the RAM.

It is important to understand how the instrument's software deals with these two sources of user information, especially during power up. When the instrument software first begins executing after loading from diskette, it strives to establish a good and uniform system of user settings. To do this, six pieces of information are obtained.

1. The CMOS image is verified using a CRC algorithm.
2. The CMOS image's version is checked against the loaded software version.
3. The PD.DAT file is verified using a CRC algorithm.
4. The PD.DAT file's version is checked against the loaded software version.
5. The diskette is checked to see if it can be written to.
6. The PD.DAT file is compared to the CMOS image to see if they match.

An error is generated if:

- Both files are bad, whether they are an old version or failed the CRC.
- PD.DAT is old or failed CRC and the diskette cannot be written to.
- PD.DAT has different settings but the diskette cannot be written to.

The CMOS RAM image is copied to PD.DAT if:

- PD.DAT failed CRC.
- PD.DAT is an old version.
- PD.DAT has different settings than the CMOS RAM image.

PD.DAT is copied to CMOS RAM if:

- The RAM image failed CRC.
- The RAM image is an old version.

Diagnostic Data Acquisition Circuit

The Diagnostic Data Acquisition circuit receives voltage data from the Vacuum Sensor, Hgb Preamp and Sensor Preamp Adapter cards and converts this for use by the instrument software. The supplies are input to an HI508a analog multiplexer. The CPU selects which input to the multiplexer is output to an AD7572 A/D converter. The A/D converter outputs digital data for the CPU, producing a digital voltage representation of medium resolution. There are eight channels used to represent the following signals:

- HGB VOLTAGE
- VACUUM READING
- WBC 26-PERCENTILE VOLTAGE
- RBC 26-PERCENTILE VOLTAGE
- WBC APERTURE CURRENT READING
- RBC APERTURE CURRENT READING
- WBC APERTURE VOLTAGE (not currently implemented)
- RBC APERTURE VOLTAGE (not currently implemented).

Utility Timer Circuit

An 8254 programmable timer device is provided as utility timer hardware (Figure 2.4-2) for use by the system software. This device has three timers that can all produce an interrupt. An interrupt control latch and buffer forms an 8-bit read/write port with the timer outputs each assigned a bit. The GAL provides the logic that controls and synchronizes the interrupts, allowing the timers to be enabled or disabled and to be used individually or chained. The GAL produces an IRQ15 system interrupt request.

Support Circuits

The support circuitry for the URA card consists of Power Supply Conditioning, a Bus Interface, an Internal Bus Controller and an Oscillator circuit.

The URA receives +5 V, -5 V and +12 V from the motherboard bus connector. It also receives +15 V and -15 V through connector J1. The +5 V, +15 V, and -15 V power supplies are fitted with a spike supressor and a large filter capacitor when they enter the card. A bypass capacitor is provided for the -5 V and +12 V power supplies.

The Bus Interface circuitry allows the URA card to communicate with the AT motherboard and follows AT convention. There is a bidirectional data bus buffer, address buffer and a command and interrupt buffer.

The URA card has its own internal data bus for the onboard logic devices. An Internal Bus Controller is responsible for the operation of this local bus.

The AT bus provides an 8-MHz clock signal, but the URA card has its own 1-MHz Oscillator circuit. The 1-MHz Oscillator circuit is used by the 8254 timer, the keypad controller chip and the A/D converter chip.

Inputs

- J1 - POWER
- J2 - PVAC (VACUUM SENSOR signal)
- J3 - AIM (from SPAD)
- J5 - KEYBOARD
- J6 - Hgb preamp
- J7 - PREAMP DIAG
- P1, P2 - AT bus edge connector

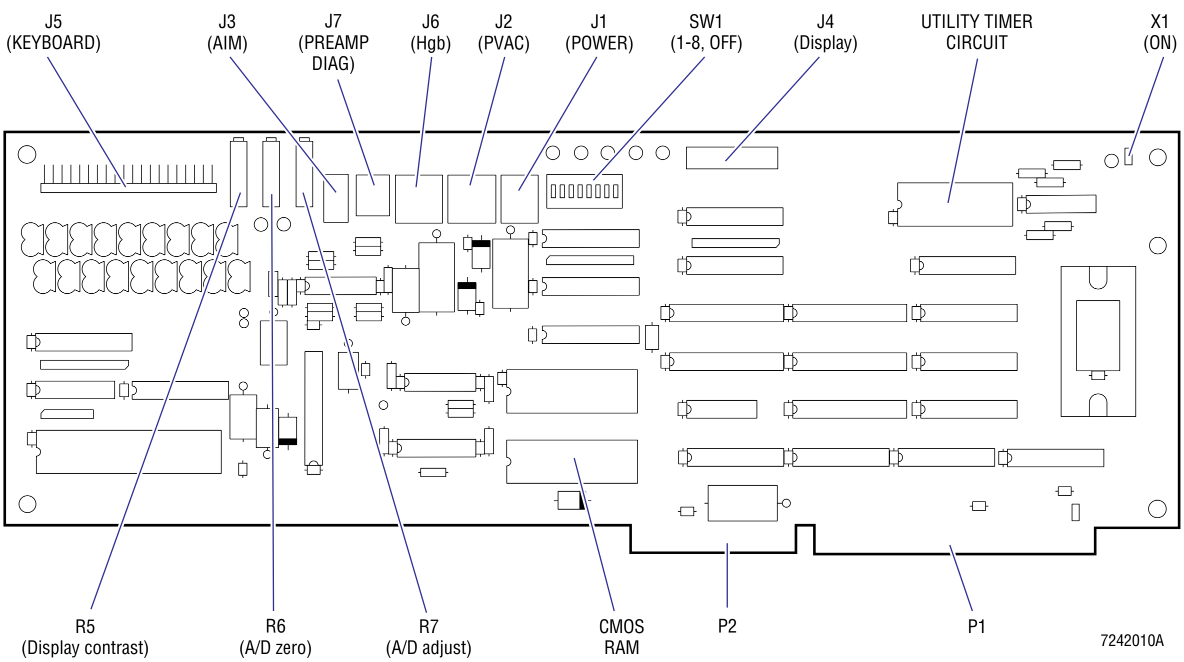
Outputs

- J4 - Display
- P1, P2 - AT bus edge connector

Adjustments

- R5 - Display contrast
- R6 - A/D converter zero adjustment
- R7 - A/D converter scale adjustment

Figure 2.4-2 URA Card



Switches and Jumpers

Table 2.4-2 URA Card Switch and Jumper Settings

Switch or Jumper	Description	MD II Setting
SW1-1	OFF - COULTER MICRO-PAK reagent ON - Bulk reagent	OFF
SW1-2	OFF - Does not create INF file ON - Creates INF file	OFF
SW1-3	OFF - Normal operation ON - Final test functions	OFF
SW1-4	OFF - Normal operation ON - Adds Service Report when SW1-3 is ON	OFF
SW1-5 to SW1-8	Not used	OFF
X1	Connects oscillator to circuitry	ON

Diluter Resource Adapter (DRA) Card

The DRA card is located in the upper chassis (Figure 2.2-1) and is a hardware interface between the AT motherboard and the Fluidics Panel motors and solenoids. This includes the vacuum pump, cycle counter and lyse pump, which are treated as solenoids by the software. There are two DRA cards used in the MD II Series and each allows the CPU to control up to four stepper motors and 14 solenoids. To accomplish its task, the card has two motor controllers and one solenoid controller, as well as support circuitry.

The DRA's output connectors are summarized in Table 2.4-3 and the jumper settings are summarized in Table 2.4-4. Figure 2.4-3 shows the location of the connectors and the location and setting of the jumpers. Tables 2.4-3 and 2.4-4 and Figure 2.4-3 are at the end of the description of the DRA card.

Motor Controller

The motor controller has two control circuits, each capable of interfacing with one motor and one solenoid. Each controller has one buffered connector, two multitimers, two logic elements and two command latches with command and status readback buffer. A motor sensor buffer is also provided as part of the motor controller package.

The motor controller connector delivers the motor phase signals for two motors and the energize command for two solenoids to the Motor/Solenoid Driver card. It also can receive up to 6-sensor signals. To protect the logic elements of the Motor Controller circuit, buffers are placed between this connector and the logic element. This provides electrical isolation from the motor phase output and the sensor input.

A multitimer is assigned to each motor. They are 8254 programmable devices with three timers. One timer is programmed with the motor step rate or frequency, the second is programmed with the number of steps, and the third timer is unused.

The logic control for each motor is a GAL 22v10. This device takes parameter input from the CPU for the motor rate, direction step mode and sensor mode (STOP on sensor or not). It also receives commands to STOP or ENABLE a motor, or not and can receive input from one sensor. This input allows the GAL to produce phase signals, control power, and generate an interrupt when a motor task is completed. The end of task interrupt (IRQ11 for DRA1 and IRQ12 for DRA2) is generated when sensor has been reached or the 8254 timer has counted the steps that it was programmed with.

Commands to the GAL are provided by an 8-bit latch. Seven bits of this latch represent the parameters SENSOR MODE, STOP, ENABLE, SENSOR ENABLE, DIRECTION, STEP and POWER. The eighth bit does not go to the GAL. It is passed through a buffer to the circuit connector and is used to control one solenoid. The output of the latch is also attached to a unidirectional bus buffer. By enabling this buffer, the host CPU can read the command latch.

A motor sensor buffer is also provided by each Motor Controller circuit. This is an 8-bit buffer that can be read by the CPU. Six bits can be used for sensors and two bits are assigned for interrupts. Each GAL is assigned one of the sensors, should it require sensor information to control a motor.

Solenoid Controller

The solenoid controller is a third Motor Controller circuit adapted to handle only solenoids. The latch bits for STOP, ENABLE, DIRECTION, and STEP modes are now used to represent four solenoids. The GAL is programmed to pass these ENABLE signals through to the four lines used for the stepper motor phases. Since each control circuit of a motor controller already handled one solenoid, the entire solenoid controller can control 10 solenoids.

Support Circuitry

The support circuitry for the DRA card consists of Power Supply Conditioning, a Bus Interface, an Internal Bus Controller, and the Oscillator circuit. The DRA card uses +5 V from the motherboard bus connector. This supply is fitted with a spike supressor and a large filter capacitor when it enters the card. A bypass capacitor is also provided for the input line of each IC.

The Bus Interface circuitry allows the DRA card to communicate with the AT motherboard and abides by the AT convention. There is a bidirectional data bus buffer, address buffer, and a command and interrupt buffer.

The DRA card has its own internal data bus for the onboard logic devices. An Internal Bus Controller is responsible for the operation of this local bus.

The AT bus provides an 8-MHz clock signal, but the DRA card has its own 1-MHz Oscillator circuit. This 1-MHz Oscillator circuit is used exclusively by the four, 8254 motor control timers.

Inputs

P1, P2 - AT bus connector

Outputs

Table 2.4-3 DRA Card Output Connectors

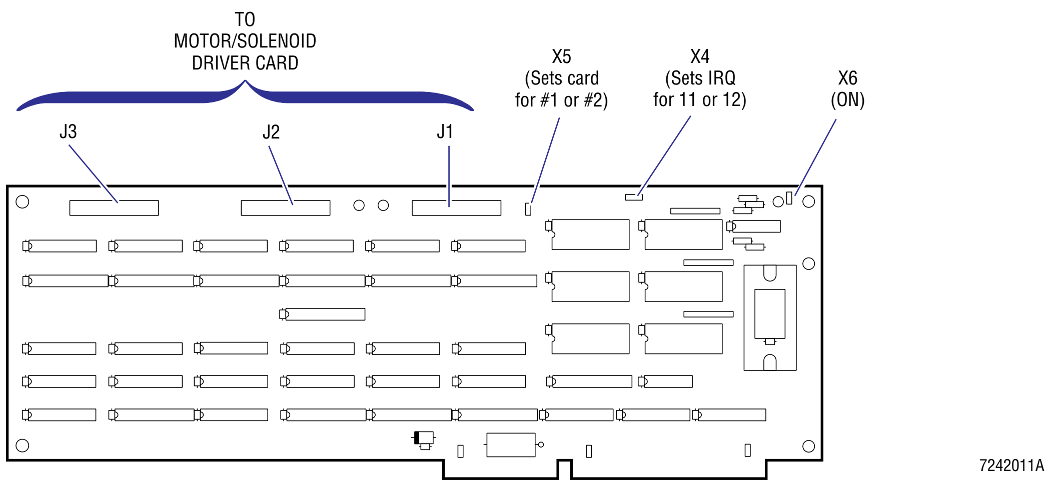
Connector	Connected To
J1	Motor/Solenoid Driver card
J2	Motor/Solenoid Driver card
J3	Motor/Solenoid Driver card
P1, P2	AT bus connector

Jumpers

Table 2.4-4 DRA Card Jumper Settings

Jumper	Description	MD II Setting
X4	Sets card for IRQ11, needed for DRA1 Sets card for IRQ12, needed for DRA2	1-3 2-3
X5	Sets card to DRA1 or DRA2	ON - DRA1 OFF- DRA2
X6	Connects oscillator to circuit when jumped	ON

Figure 2.4-3 DRA Card



Motor/Solenoid Driver Card

The Motor/Solenoid Driver card is located in the lower chassis (Figure 2.2-2). It receives direction from the DRA cards in the upper chassis and distributes power to Fluidics Panel components, such as motors, solenoids, and the vacuum pump. It also provides an overload timer for the +24 V power supply, power for the instrument sensors, and logic to control the lyse solenoid pump, the POWERFAIL (PF/PG) signal, and the +24 V POWER ON signal.

The Motor/Solenoid Driver card's input connectors are summarized in Table 2.4-5, the output connectors are summarized in Table 2.4-6, the test points are summarized in Table 2.4-7, the jumper settings are summarized in Table 2.4-8 and the locations of the connectors and jumpers are shown on Figure 2.4-4. Tables 2.4-5 through 2.4-8 and Figure 2.4-4 are at the end of the description of the Motor/Solenoid Driver card.

Motor Driver

All motors use the same Motor Driver circuit, which uses a UDN2878W driver device. Four phase signals are input from the DRA card(s). The driver outputs four +24 V lines to the motor in the phases set by the DRA card(s).

An Overload Timer circuit on the Motor/Solenoid Driver card offers protection to the motors and drivers. The +24 V, which is received by the Motor Driver circuit's 25-W resistors, is delivered through Q3, a 10-A transistor. The base of Q3 is controlled by the output of an LM339 comparator. When +24 V is directed to a motor, it is also presented to an RC timer (R1 and C1). C1 is input to the comparator along with +16 V, and when C1 charges higher (about 2 minutes), Q3 stops conducting. This cuts off the +24 V power supply from the motor drivers. The +24 V overload latch is also set, which allows the instrument software to detect that an overload occurred.

Solenoid Driver

The command to energize a solenoid reaches the Motor/Solenoid Driver card by way of a DRA card. These signals are received by the card and latched using a 74HCT540 device. The output of the latch for most solenoids is fed directly into a ULN2823 driver device that applies +24 V to the designated solenoid.

The lyse pump is one exception. The LYSE PUMP signal from the latch is first passed through a programmable logic device before entering the ULN2823 driver device. This logical circuit enables a timer that de-energizes the lyse pump after 1 second.

Four solenoids, LV6, LV7, LV10, and LV11 use a UDN2878W driver device. This is a motor driver that was used to energize larger solenoids in earlier versions of the instrument.

Sensor Control

All the system sensors are tied to the Motor/Solenoid Driver card. They are provided with a current source for the LED and +5 V for the detector. The detector output is received and made available to the proper DRA card. Most sensor signals are sent directly to the DRA card, but the traverse sensors are treated differently. The traverse has two motors which STOP on sensor and five sensors. The motor driver logic on the DRA card can take input from only one sensor for each motor. A multiplexer is used to select the proper sensor signal for output to the DRA card. The three horizontal position sensors are multiplexed for use by the traverse motor and the two vertical sensors are multiplexed for use by the probe motor. The Multiplexer circuit is implemented as part of the programmable logic device.

+24 V POWER ON Signal

The +24 V power supply has a POWER ON signal input. When this signal is high or floating (disconnected), the power supply is turned on. When the input is low or grounded, the power supply will not output +24 V. The MD II Series uses this feature and connects a POWER ON signal from the Motor/Solenoid Driver card.

When the software loads and begins executing, a command is sent from the DRA card to the Motor/Solenoid Driver card to turn on the +24 V power supply. This command is processed by a programmable logic device, U21, which sets an output latch. The output of the latch is inverted (low when the latch is set) and applied to the base of transistor Q4. If the base of Q4 is low, Q4 does not conduct, which causes the line to float and turn on the +24 V. There is a jumper, X1 (Figure 2.4-4), in this line as well. If it is removed, the +24 V power supply always turns on.

At power up, the programmable logic device is reset, which clears all latches. This causes Q4 to conduct, grounding the POWER ON signal. The system remains in this state with the +24 V off until the instrument's software is loaded and turns on the +24 V.

+24 V POWERFAIL (PF/PG) Signal

The +24 V power supply outputs a POWERFAIL signal. This signal indicates failure to produce +24 V within factory-set limits, a brownout of at least 38 ms, or a temperature overload on the supply. The MD II Series monitors this signal. The signal is connected to a latch on the Motor/Solenoid Driver card. This latch is part of a programmable logic device and is polled by the instrument software when it does a +24 V power supply check. It is important to realize that the latch remains set even after the condition that caused it to be set goes away.

Inputs

Table 2.4-5 Motor/Solenoid Driver Card Input Connections

Connector	Connected To
J1	DRA2, J1
J2	DRA2, J2
J3	DRA2, J3
J4	DRA1, J1
J5	DRA1, J2
J6	DRA1, J3
J15	+24 V, POWER ON, POWERFAIL
J18	Resistor bank
J23	Resistor bank

Outputs

Table 2.4-6 Motor/Solenoid Driver Card Output Connections

Connector	Connected To
J7	Solenoid Interconnect card
J8	Peristaltic pump motors
J10	Syringe Assembly and traverse motor
J11	Flex Connect card
J12	Not used

Test Points

Table 2.4-7 Motor/Solenoid Driver Card Test Points

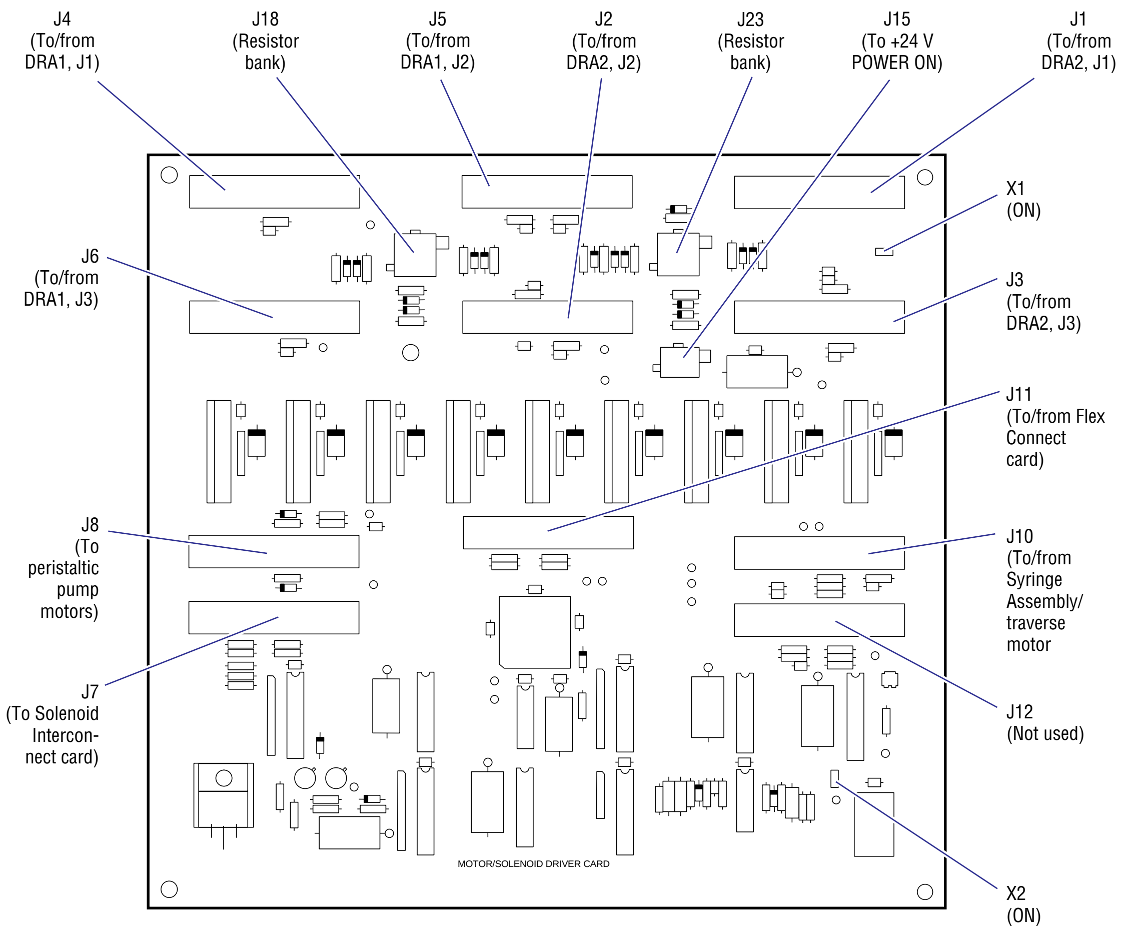
Test Point	Supply
TP1	Overload Timer input to comparator
TP2	Overload Timer output
TP3	Common ground
TP4	Lyse sensor output
TP5	Overload timer reference (16 V)
TP6	+24 V supply
TP7	Waste level output
TP8	Probe-wipe down sensor output
TP9	Probe-wipe upper sensor output
TP10	Diluent sensor output
TP11	Spare sensor output
TP12	Probe WBC position sensor output
TP13	Probe aspirate position sensor output
TP14	Probe RBC position sensor output
TP15	Aspirate syringe sensor output
TP16	Diluent syringe sensor output
TP17	POWER ON signal (to +24 V supply)
TP18	Overload Timer +24 V input supply
TP19	Spare sensor output
TP20	Spare sensor output
TP21	Spare sensor output
TP22	Spare sensor output
TP23	Oscillator output

Jumpers

Table 2.4-8 Motor/Solenoid Driver Card Jumper Settings

Jumper	**Description**	**MD II Setting**
X1	+24 V control	ON
X2	ON - Connects oscillator to circuit OFF - Disconnects oscillator for card testing	ON

Figure 2.4-4 Motor/Solenoid Driver Card



2.5 DATA ACQUISITION

The data acquisition section is responsible for the accumulation and measurement of system data that is used to determine final system output (instrument results). The data acquisition section includes the:

- Sensor Preamp Adapter (SPA) card
- Hgb Preamp card
- Vacuum Sensor card
- SPAD card.

Sensor Preamp Adapter (SPA) Card

The Sensor Preamp Adapter card is located in the lower chassis (Figure 2.2-2) and has three distinct circuits:

- The Preamp circuit
- The Dc Restorer circuit
- The High-gain Stage circuit.

Signals are input from the RBC and WBC aperture sensors in the form of current pulses. These pulses are preprocessed by the Sensor Preamp Adapter card and then passed on to the SPAD card for further processing.

The first stage of the Sensor Preamp Adapter card is the Preamp circuit. This circuit provides a constant current source for the aperture system, and changes in aperture resistance produce voltage pulses. In effect, the Preamp is a current-to-voltage converter that senses changes in the current source it provides and passes voltage pulses to the Dc Restorer circuit. An aperture zap of ≈200 V, supplied by the Linear Power Supply card, is applied through this stage to dynamically clean the apertures.

The Dc Restorer circuit receives these voltage pulses and provides the proper dc offset required by the SPAD card. This circuit ensures that the voltage output will always be positive.

The last stage of the Sensor Preamp Adapter card is a times-eight signal conditioner, which produces a suitable signal amplitude to pass on to the SPAD card.

Input connections for the Sensor Preamp Adapter card are summarized in Table 2.5-1, output connections are summarized in Table 2.5-2, and jumper settings are summarized in Table 2.5-3. Figure 2.5-1 shows jumper locations and settings and the location of input and output connectors.

Inputs

Table 2.5-1 Sensor Preamp Adapter Card Input Connections

Connector	Description
J1	High voltage supply
J2	Analog power entry (from Linear Power Supply card)
J7	Diagnostics
J8	WBC APERTURE signal
J10	RBC/PLT APERTURE signal

Outputs

Table 2.5-2 Sensor Preamp Adapter Card Output Connections

Connector	Description
J3-J6	Analog power distribution (out)
J9	WBC signal
J11	RBC signal
J12	PLT signal

Adjustments

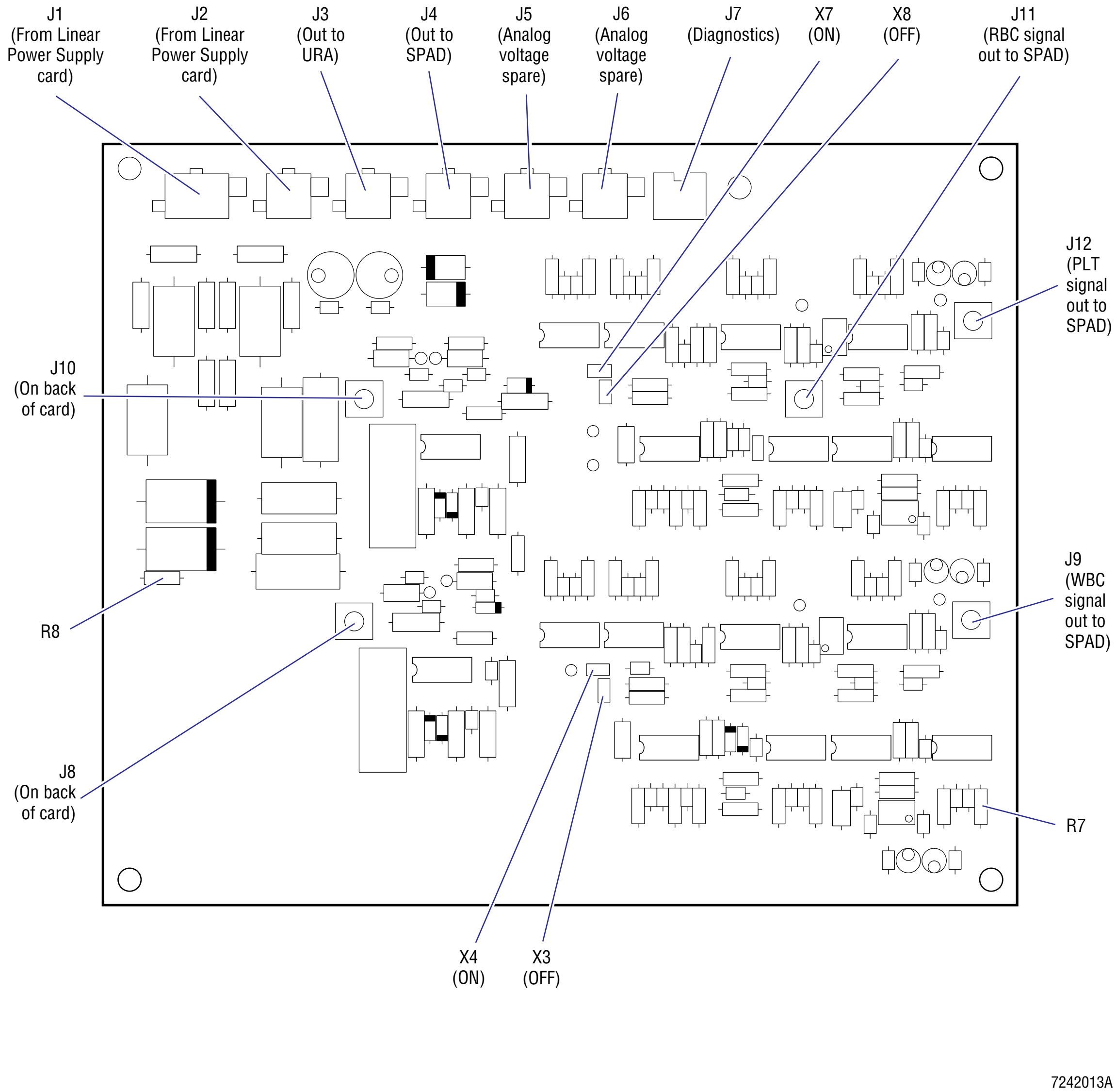
There are four adjustable resistors on this card. They are adjusted at the factory to set dc levels in the Preamp and Dc Restorer stages. The adjustment requires a test setup that is impractical for field procedures.

Jumpers

Table 2.5-3 Sensor Preamp Adapter Card Jumper Settings

Jumper	Description	MD II Setting
X3	Grounds WBC Dc Restorer input for subassembly adjustment and testing.	OFF
X4	Connects WBC Preamp output to Dc Restorer circuit.	ON
X7	Connects RBC Preamp output to Dc Restorer circuit.	ON
X8	Grounds RBC Dc Restorer input for subassembly adjustment and testing.	OFF

Figure 2.5-1 Sensor Preamp Adapter Card



Hgb Preamp Card

The Hgb Preamp card is located in the lower chassis (Figure 2.2-2). It is a hemoglobin detector amplifier producing the HEMOGLOBIN signal for the URA card. The Hgb Preamp card is a variable gain (to 11 times) amplifier and a current-to-voltage converter. It takes the current signal from the Hgb detector mounted to the WBC bath, amplifies it and converts it, then sends it to the URA card. An A/D converter on the URA card makes the information available to the system program.

There are two adjustments built into the amplifier, one for adjusting overall gain and one for adjusting the amplifier offset. The gain adjustment compensates for optical differences in the light path and optical components. It assures an output voltage to the URA card that provides maximum resolution of the A/D converter. The offset adjustment is used to compensate for

dark current from the detector. There is interaction between these two adjustments, so they must be adjusted together.

Inputs

- J1 - Hgb photodetector
- J2 - ±15 V

Outputs

- J2 - Hgb output voltage
- J3 - Hgb lamp output: currently not used

Adjustments

- R7 - Hgb Preamp adjustment (adjusts output voltage)
- R8 - Preamp offset adjustment (adjusts Hgb zero)

Test Points

- TP1 - orange, Hgb Preamp card output
- TP2 - black, Hgb Preamp card ground

Vacuum Sensor Card

The Vacuum Sensor (Vacuum Sense/Vent Valve) card is located in the lower chassis (Figure 2.5-2) and provides a means of accurately reading count vacuum. It accepts a vacuum input from 0.0 in. Hg to 7.0 in. Hg and converts it to an electrical signal from 0.0 V to 5.0 V. The card also is host to two solenoid valves, LV1 and LV2. LV1 connects the vacuum sensor to the VIC or to atmosphere. LV2 controls the VIC vent to atmosphere, which is required when the chamber is being drained. A block diagram showing the functioning of the Vacuum Sensor card is shown in Figure 2.5-2.

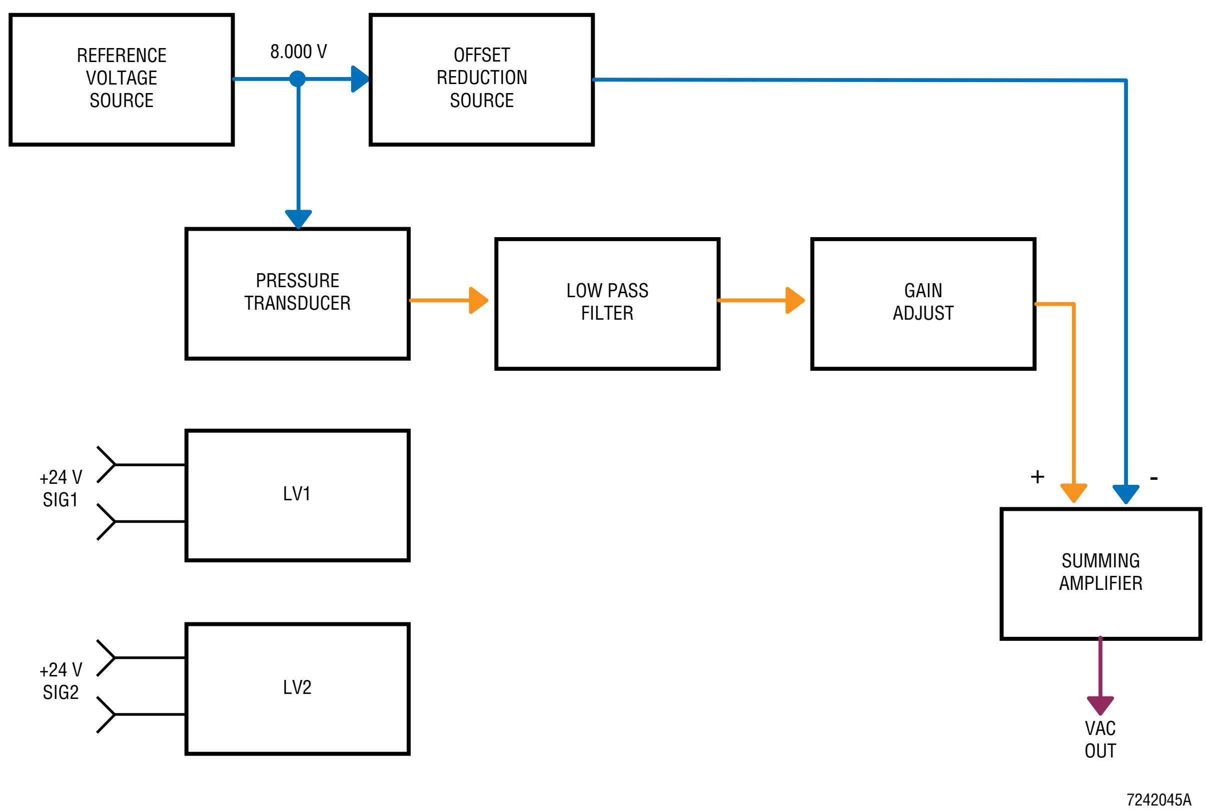
The main component of the Vacuum Sensor card is U1, a differential pressure transducer that outputs a voltage relative to the pressure difference at its input ports, P1 and P2. Port P1 in the MD II implementation is always open to atmosphere, while P2 is connected to LV1, which determines the pressure source to be measured. The voltage output of U1 is fed through a low-pass filter and amplifier section that filters out electrical noise and sets the gain. This voltage is fed through a summing amplifier along with the offset reduction source voltage to produce the final VAC OUT voltage level.

The offset reduction source is a negative voltage close to 1.0 V. Since the pressure transducer outputs about 1.0 V when there is zero pressure differential, the offset reduction lowers this output to near, but greater than, 0.0 V, producing better resolution with the expected output range of 0.0 V to 5.0 V.

To measure vacuum, LV1 is first energized, which connects P2 to atmosphere. A reading is taken that establishes the zero reference voltage. LV1 is then de-energized, connecting P2 to the VIC, and the high reference voltage reading is taken.

The vacuum measurement is the difference between these two reference readings. During a sample analysis cycle, one zero reference is taken prior to the first count period, and a high reference voltage reading is taken for each of the 12 count periods. This produces a vacuum measurement for each of the count periods.

Figure 2.5-2 Vacuum Sensor Card Block Diagram



The input and output connectors and test points for the Vacuum Sensor card are shown in Figure 2.5-3 and the test points are summarized in Table 2.5-4.

Inputs

- J1 - ±15 V
- J2 - solenoid LV1
- J3 - solenoid LV2

Outputs

J1 - VAC OUT

Adjustments

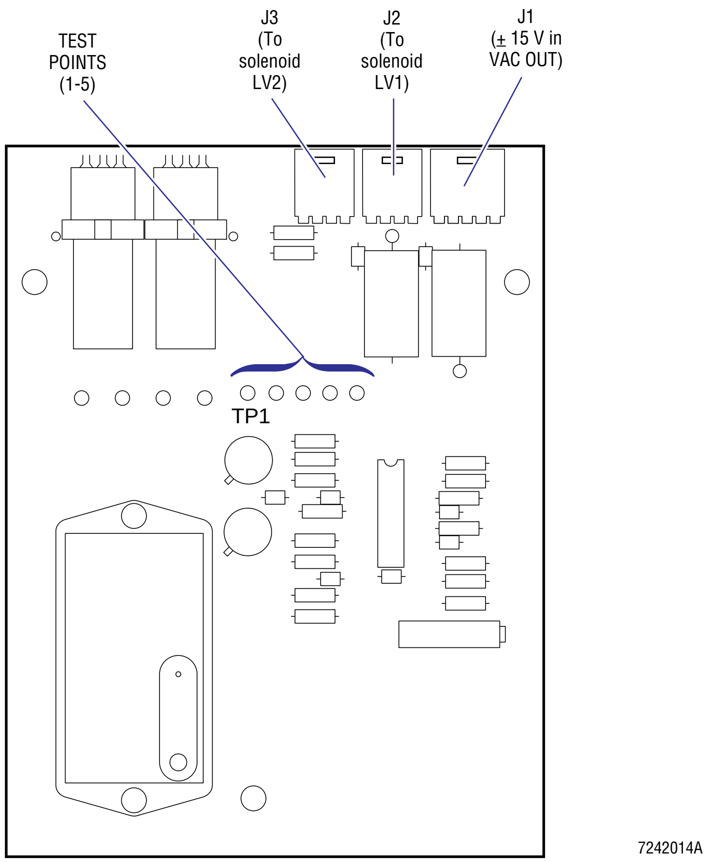
R2 - The Gain adjustment calibrates the card and requires an accurate vacuum measuring device to set it. It is a factory adjustment that cannot and must not be adjusted in the field.

Test Points

Table 2.5-4 Vacuum Sensor Card Test Points

Test Point	Description
TP1	8.006 V reference voltage (7.964 V to 8.049 V)
TP2	Transducer output
TP3	Gain adjustment output
TP4	Ground
TP5	VAC OUT

Figure 2.5-3 Vacuum Sensor Card



Sensor Processing Adapter with Diagnostics (SPAD) Card

The SPAD card is located in the upper chassis (Figure 2.2-1). Its primary function is to acquire and process instrument data. The SPAD card is a full-size, AT-type card designed to plug into a 16-bit slot in the AT motherboard.

The SPAD card acquires WBC, RBC, and Plt pulse data from the Sensor Preamp Adapter card. This data is counted, edited, channelized, and converted to digital format. It is then made available to the processing software via the AT bus interface.

The SPAD's input connections are summarized in Table 2.5-5 and their location is shown on Figure 2.5-4. Figure 2.5-4 also shows the location and setting of the jumper. Table 2.5-5 and Figure 2.5-4 are at the end of the description of the SPAD card. The card is comprised of the following circuitry.

Power Supply Conditioning

This card receives +5 V from the +24 V power supply through the AT bus slot and ±15 V from the Linear Power Supply card through connector J4. These regulated supplies are further conditioned by the SPAD card with a Spike Suppressor circuit and a large filter capacitor. In addition, each IC on the card has a bypass filter capacitor.

Oscillator Circuit

A 16-MHz, onboard oscillator is directed into the three programmable logic devices, U22, U23 and U33. These devices buffer, divide, use and supply the timing signals for other circuits on the card.

Control Functions

Card housekeeping consists of several logical functions, an AT Bus Interface, an Internal Bus Controller, the Main Port Address Decoder, Control Port 1, and Control Port 2. These circuits or functions do not use discrete components or specialized chips. They are programmed on chip U23, labeled ASPAD, which is an Electrically Programmable Logical Device (EPLD).

The AT Bus Interface provides the circuitry allowing communication to and from the AT motherboard. It is comprised of a bidirectional data buffer, an address buffer, and the command and interrupt buffer and conforms to AT slot specifications. There is also an Internal Bus Controller.

The SPAD card has its own data bus. The Internal Bus Controller is the controller for this internal bus.

The Main Port Address Decoder supplies the chip select signals for all the chips on the SPAD card.

Control Port 1 is a Read/Write port providing four control signals/commands:

- SELECT (for Red/White 26-percentile sync)
- CLEAR (the state machine)
- INTERRUPT ENABLE (DMA terminal count)
- INTERRUPT ENABLE (8-channel DAS)

Control Port 2 is a Read/Write port providing eight control signals/commands:

- APERTURE CURRENT ON/OFF
- RED APERTURE SELECT
- WHITE APERTURE SELECT
- APERTURE CLEAR
- EDITOR ENABLE/DISABLE
- PRECHARGE ON/OFF
- COUNTER CLEAR
- COUNTER ENABLE

Octal Digital-to-Analog Converter (DAC)

The octal DAC contains eight identical DACs. They are attached to a common reference but are individually latched. They provide:

- RBC aperture current voltage setting (coarse and fine)
- WBC aperture current voltage setting (coarse and fine)
- RBC counting threshold
- WBC counting threshold
- Plt lower and upper thresholds.

Aperture Signal Processing

The signal processing functions are programmed into another EPLD. This programming actually spans two chips, U22 and U33. They are labeled BSPAD, and contain the WBC processor and the RBC/Plt processor. These processor functions are capable of running concurrently, allowing information from the RBC and WBC baths to be processed at the same time, speeding up the instrument cycle.

The WBC processor counts and channelizes pulses that it receives from the WBC preamp (on the Sensor Preamp Adapter card). As they are received by the processor, all pulses are sent to the channelizing section, but only pulses that exceed a threshold are sent to the 17-bit counter. This threshold is set by the system software and allows pulses representing particles greater than 35 fL to be counted. Pulses sent to the channelizing section are first edited. The editor issues a "good pulse" strobe based on the shape, size, and width of the pulse. If a pulse is judged to be good, it is peak detected and applied to the input of an A/D converter. The 8-bit output of the A/D converter is then transferred directly to memory and forms the channelized data or histogram.

The RBC/Plt processor counts and channelizes pulses that it receives from the RBC and Plt preamp (on the Sensor Preamp Adapter card). RBC pulses received by the processor are sorted according to thresholds established by the CPU. Pulses that exceed a threshold representing 36 fL are sent to the 17-bit counter where they are counted as RBC cells.

Pulses that fall into a threshold range representing 2 to 20 fL are considered Plts and are peak detected and sent to an A/D converter. The peak detector is used to hold the peak amplitude until the A/D process is finished. The output of the A/D converter designates a memory location to be incremented, creating the Plt histogram as a series of memory locations. All pulses not considered Plts are sent to the RBC editor and channelizing section. The editor issues a "good pulse" strobe based on the height, shape and width of the pulse. If a pulse is judged to be good, it is peak detected and applied to the input of an A/D converter. The 8-bit output of the A/D converter is then transferred directly to memory and forms the channelized data or RBC histogram.

Data Acquisition Circuit

There is a Data Acquisition circuit on the SPAD card that is used to monitor the +5 V, +12 V and +15 V power supplies. They are monitored using the system software DVM function. The Data Acquisition circuit is contained on chip U39. It is an eight-channel device with the following instrument data assigned to three of the eight channels:

- +5 V supply
- +12 V supply
- +15 V supply
- Five channels are currently not used.

Test Pulse Generator

A test pulse generator has been established on the SPAD card with two ICs. U40 is a logic chip that establishes the pulses and U38 is the A/D converter used by the logic chip. The MD II uses this test pulse generator to create a RAMP pulse train during the **PULSE TEST** accessed from the Service menu. The SPAD card processes this pulse train and generates a report. If Auto Print is active, histograms are also displayed.

Interrupt Selector

The interrupt selector is responsible for signaling the CPU with an interrupt request and determining what interrupt level to use.

Input

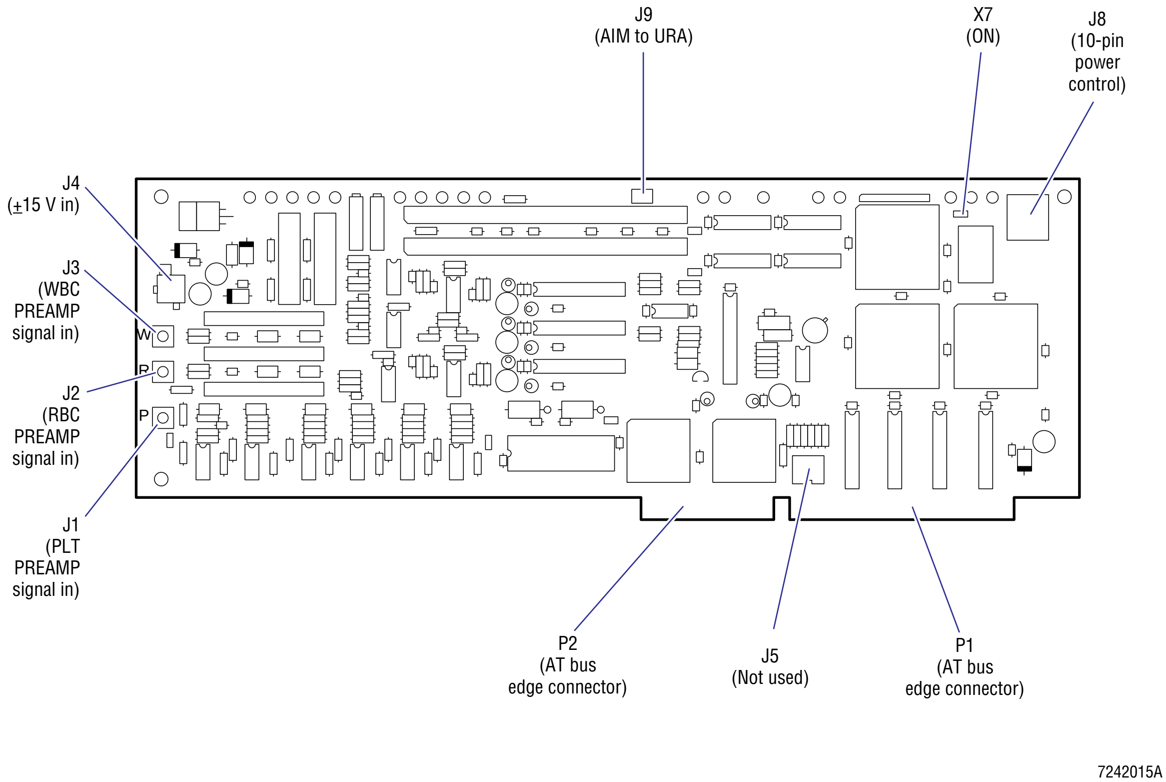
Table 2.5-5 SPAD Card Input Connections

Connectors	Connected To
P1, P2	AT bus edge connector (card uses +5 V from the AT bus)
J1	PLT PREAMP signal
J2	RBC PREAMP signal
J3	WBC PREAMP signal
J4	±15 V
J5	Voltage monitor (for future use)
J8	10-pin power control
J9	RBC and WBC AIM voltage (to the URA card)

Outputs

P1, P2 - AT bus edge connector

Figure 2.5-4 SPAD Card



Jumper

X7 (Set to ON)

- ON - Connects oscillator to circuit
- OFF- oscillator for card testing

Adjustments

There are two potentiometers onboard, R85 and R86. These are factory adjustments affecting the Editor circuit and require an oscilloscope and pulse generator to set them. They **cannot** and **must not be** adjusted in the field.

2.6 PERIPHERALS

Floppy Disk Drive

The floppy disk drive is a standard 3.5 in., 1.44 MB, Double-sided High-density drive. The main system program is loaded from this drive on power up or reboot. A program disk is used to power up the instrument, but a calibration or control disk may be requested. Software updates merely require that the new program disk be used at power ON.

Display

Visual output is provided by a 4-row by 40-column, character only LCD. This display (Figure 2.2-1) has an operating temperature range of 0 to 50°C. Electrical input consists of one 16-pin connector, connected through a ribbon cable to the URA card. Pins 1 through 8 are the data bus, pins 9 through 12 are the control lines, pin 13, V_0, is the display contrast voltage, pin 14, V_{DD}, is the +5 Vdc power supply, and pins 15 and 16 are the ground pins.

The display is a component piece purchased from an outside vendor, so low-level troubleshooting is not an option.

Keypad

The MD II keypad (Figure 2.2-1) is a 36-switch, non-tactile, membrane keypad with a graphic overlay. The MD II makes use of only 24 switches. All switches are environmentally sealed with an operating temperature range of +10 to +35°C. Switch selection uses a standard row/column matrix methodology, output through a 20-pin flex ribbon cable to the URA card. A separate flex cable for the built-in electrostatic shield is connected to the chassis for grounding.

Both cables are part of the component as purchased and **cannot** be changed separately.

Rear Panel Interface Connectors

There are three interface connectors on the rear panel, Serial 1, Serial 2 and the Parallel Printer connector (Figure 3.2-2). All three connectors attach directly to the AT motherboard. Serial 1 is a 25-pin, RS-232 serial connector and Serial 2 is a 9-pin, RS-232 serial connector. Serial 1 is used for the ASTM host interface while Serial 2 is unused. The Parallel Printer connector is a standard Centronics 25-pin output connector that is used for the system Printer. Pinouts for the serial ports are shown in Table 2.6-1.

Table 2.6-1 Pinouts for Serial Ports

Function	Direction	Serial 1 (25 Pin)	Serial 2 (9 Pin)
No Connection	N/A	1 (shield)	N/A
Transmitted Data	From MD II	2	3
Received Data	To MD II	3	2
Request To Send	From MD II	4	7
Clear To Send	To MD II	5	8
Data Set Ready	To MD II	6	6
Signal Ground	N/A	7	5
Data Terminal Ready	From MD II	20	4
Ring Indicator	To MD II	22	9

3 INSTALLATION PROCEDURES, 3.1-1

PART A: INSTRUMENT INSTALLATION

3.1 PREINSTALLATION CHECKS, 3.1-1
Space and Accessibility Requirements, 3.1-1
Power Requirements, 3.1-1

3.2 INITIAL SETUP, 3.2-1
Unpack the Instrument, 3.2-1
Connect the Reagents, 3.2-2
Connect the Printer, 3.2-3
Enter the Initial Settings, 3.2-4

3.3 INSTRUMENT VERIFICATION, 3.3-1
Startup the Instrument, 3.3-1
Calibrate the Instrument, 3.3-1

PART B: UPGRADE AND OPTION INSTALLATION

3.4 OPTIONAL TICKET PRINTERS, 3.4-1
Epson TM-290P Slip Printer, 3.4-1
Purpose, 3.4-1
Single-Printer Setup Procedure, 3.4-1
Two-Printer Setup Procedure, 3.4-3

ILLUSTRATIONS

3.1-1 System Electrical Connectors, 3.1-2

3.2-1 Reagent Connections, 3.2-2
3.2-2 System Electrical Connections, 3.2-3
3.2-3 CITIZEN GSX-190 Printer settings, 3.2-4

3.4-1 Epson TM-290P Slip Printer, 3.4-1
3.4-2 DIP Switch, SW1, Location, 3.4-2
3.4-3 Printer Connections for a Single Printer, 3.4-2
3.4-4 Printer Connections for Two Printers, 3.4-4

TABLES

3.1-1 Space Requirements, 3.1-1
3.1-2 Connectors' Part Numbers and Line Input Ranges, 3.1-2

PART A: INSTRUMENT INSTALLATION

3.1 PREINSTALLATION CHECKS

Space and Accessibility Requirements

If the reagent pack will be placed on the floor, measure the bench height. The reagent pack should not be more than 36 in. below the lyse pump. This allows for a bench height of about 32 in.

Check the site for proper space allocation (Table 3.1-1)

Table 3.1-1 Space Requirements

Linear Dimensions	Required by Instrument	Preferred by Service
Depth	19.23" plus 3" for ventilation	32"
Width	20"	36"
Height	17.9"	32"

Power Requirements

IMPORTANT May compromise instrument results. If you use an extension cord, you could encounter electrical interference that could affect the instrument's results. Locate the instrument close enough to a power outlet that an extension cord is not necessary.

1. Check for the availability of a power connector.

   Make sure the instrument is close enough to a power outlet that the ac power cable safely reaches it. The ac power cable is 6 ft long and facing the back of the instrument, it is connected in the lower left corner (Figure 3.1-1).

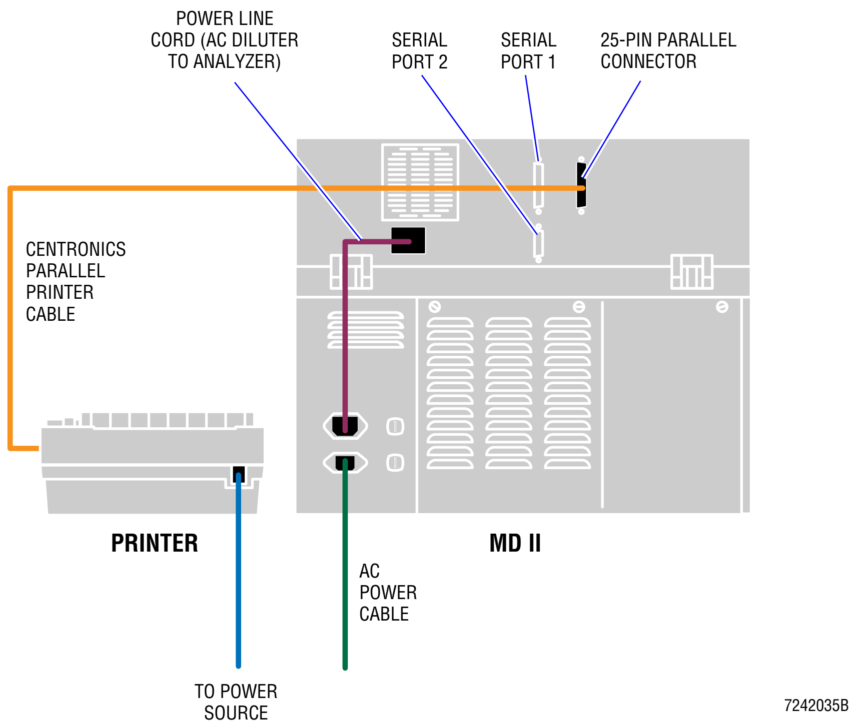
2. Measure the system power:
   - The MD II Series is labeled and sold for three power ranges, 100 Vac, 120 Vac and 230 Vac.
   - The system can be configured for four different power ranges. Table 3.1-2 shows the four power ranges and a part number for the associated configuration jumper.

Table 3.1-2 Connectors' Part Numbers and Line Input Ranges

Connector	Range	Part Number
100 VOLTS	90 - 110 Vac	6028623-0
120 VOLTS	110 - 132 Vac	6028600-1
220 VOLTS	198 - 242 Vac	6028624-8*
240 VOLTS	220 - 264 Vac	6028625-6*

* An assembly, PN 6706318-0, is included with the 230 Vac instrument. It has both the 200 VOLTS and 240 VOLTS connectors.

Figure 3.1-1 System Electrical Connectors



3.2 INITIAL SETUP

Unpack the Instrument

1. Unpack all boxes.
2. Using the packing list, ensure that no items are missing including the proper reagents, controls and calibrators.
3. Check the instrument for damage.
4. Check that the instrument has caution and compliance labels near the power connector.
5. Measure the line voltage that the MD II will be plugged into. Verify that the instrument version (100 Vac, 120 Vac or 230 Vac) matches this line voltage. (The range and part number are stamped on the serial number tag and also listed in Table 3.1-2.)
6. Remove packing materials. Open the lower chassis as necessary:
   - Wire wrap around the vacuum pump
   - Foam insert underneath the vacuum pump
7. Ensure that cards and connectors are seated properly in the lower chassis.
8. Verify that the AC Power/Vacuum Relay card is configured for the proper voltage range. (Use Table 3.1-2 to match the proper range to the connector/jumper label.) The 230 VOLTS instruments ship with the higher-range connector (240 VOLTS) installed and also include the lower-range connector, should the input supply be 220 Vac or lower. Change to the 200 VOLTS jumper at this time if appropriate.
9. Lower the upper chassis and remove the upper chassis cover.
10. Check that all cards are seated properly, no connectors are loose, and all the DIP switches and jumpers are set correctly. Refer to Appendix A for the correct settings, if necessary.
11. Verify that the AT power supply Ac Select switch is set to 115 for 100 Vac or 120 Vac units and 230 for 230 VOLTS units. This switch is covered by the chassis rear panel and can just be seen through the power cable cutout. To switch voltage settings, you must remove the power supply.
12. Connect cables and power cords (Figure 3.1-1).

CAUTION Risk of damage to equipment. Turning the instrument's power ON before the instrument is completely setup could damage the instrument. Do not turn the instrument's power ON until you have completed connecting the reagents and the Printer.

13. Install the peristaltic pump tubing around the pump spooler.

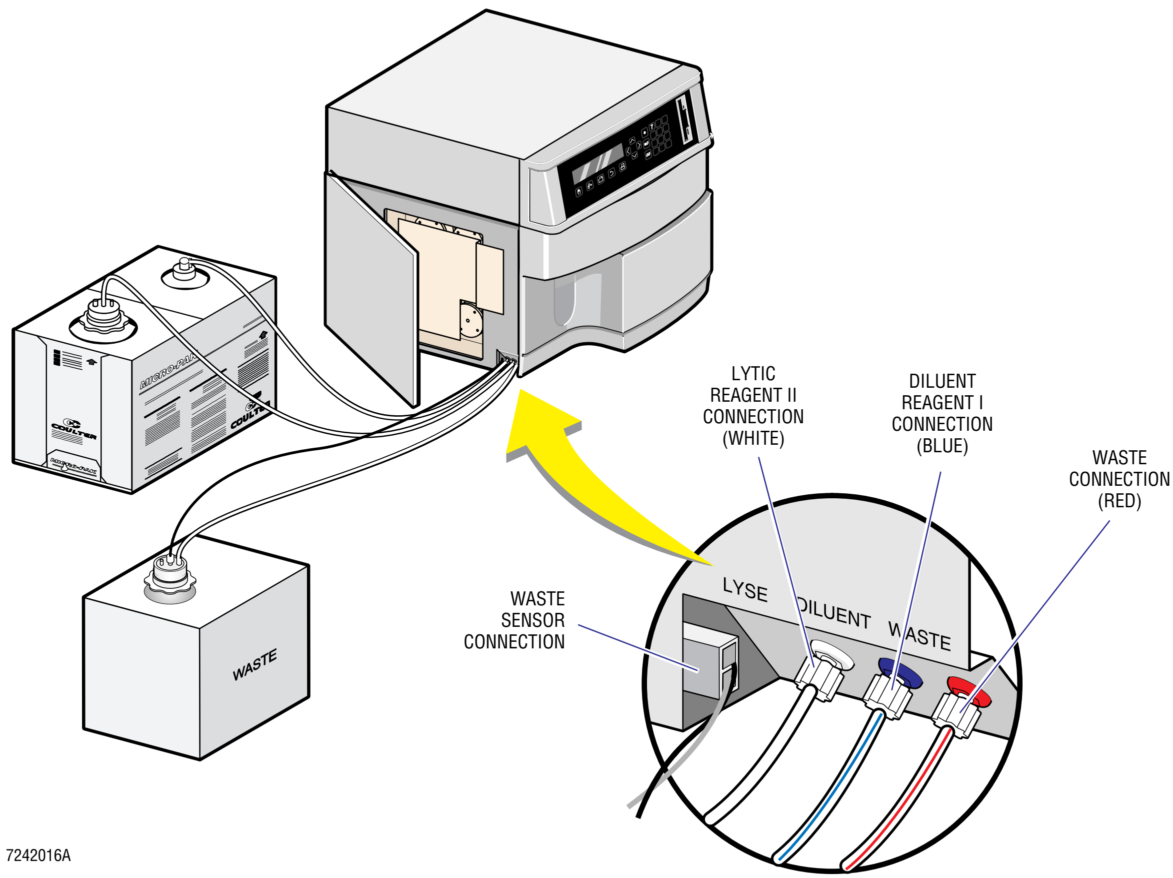
    Note: Manually turn the pump several revolutions. If this is not done, the motor may not be able to turn the pump.

Connect the Reagents

The connections for the reagents are at the bottom right corner on the left side of the instrument (Figure 3.2-1).

1. Connect the diluent reagent using blue stripe tubing (PN 3202209-0) to the blue fitting (diluent). Use a Luer fitting (PN 6232503-8).
2. Connect the lytic reagent using EVA tubing (PN 3202221-9) to the white fitting (lyse). Use a Luer fitting (PN 6232503-8). Use polyurethane tubing (PN 3202036-4) to couple the EVA tubing to the Luer fitting and to the pickup tube.
3. Ensure that the lyse container is no higher than 6 in. above or lower than 36 in. below the lyse pump and that the lyse tubing is no longer than 5 ft.
4. Connect the waste container using red stripe tubing (PN 3202205-7) to the red fitting (waste). Use a Luer fitting (PN 6232503-8).
5. If a cubitainer is used for waste, connect the waste alarm cable (PN 6028669-8) between the waste pickup tube and the waste sensor connector. The waste sensor connector is located to the left of the white fitting (lyse).

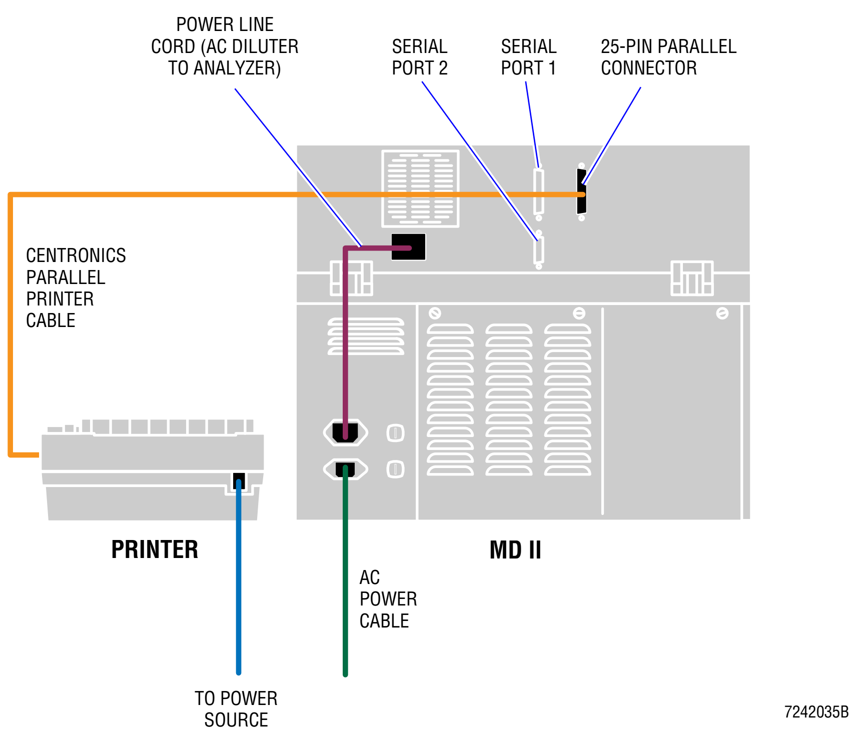
Figure 3.2-1 Reagent Connections



Connect the Printer

1. Determine which type of Printer(s) need to be installed.
   - To install the standard Graphic Printer only, follow this procedure.
   - To install the optional Ticket Printer or the optional Ticket Printer and the Graphic Printer, go to Heading 3.4, OPTIONAL TICKET PRINTERS.
2. Connect the Printer cable between the Printer and the 25-pin parallel connector at the back of the MD II (Figure 3.2-2.).

Figure 3.2-2 System Electrical Connections



3. Load paper into the Printer.
4. Set the Printer configuration for MD II use.

ATTENTION: The procedures for setting the configuration and the sequence of setting the configuration and powering up the Printer depends upon the specific Printer. Refer to the Printer manual for instructions on how to set the Printer's configuration.

The Printer must be an Epson-compatible Printer, but should be set for IBM® emulation since some characters are used from the IBM character set. Paper size must be set to 8.5 in. by 11 in. Other settings or options can be set to the customers' preference. If the site is using the CITIZEN GSX-190 printer, use the configuration settings in Figure 3.2-3.

5. If you have not plugged the Printer into an available power source and turned the Printer on, do so now.

Figure 3.2-3 CITIZEN GSX-190 Printer settings

CITIZEN GSX-190

Default Setting Report

Default settings are **EMPHASIZED**.

INSTALL 1							
RIBBON	**NORMAL**	COLOR					
A.S.F.	**OFF**	ASF+ENV	ASF				
EMULATION	EPSON	**IBM**					
PRINT STYLE							
FONT	**DRAFT**	HS-DRAFT	ROMAN	SANS SER	COURIER	PRESTIGE	SCRIPT
	ORATOR						
EMPHASIZED	**OFF**	ON					
PITCH	**10 CPI**	12 CPI	15 CPI	PROPORTIONAL			
FONT LOCK	**OFF**	ON					
PAGE LAYOUT							
LINE SPACING	**6 LPI**	8 LPI					
FORM LENGTH	5 INCH	7 INCH	**LETTER**	A4	12 INCH	LEGAL	
PRINT MODE							
NLQ DIR	BI-DIR	**UNI-DIR**					
GRAPHIC DIR	BI-DIR	**UNI-DIR**					
CHARACTER							
SLASH ZERO	**OFF**	ON					
CHARACTER SET	**SET 1**	SET 2					
CODE PAGE	**U.S.A.**	MULTI	PORTUGAL	CANADA	NORWAY	SCANDNVA	TURKEY
	ICELAND	WINDOWS					
INSTALL 2							
TEAR OFF	OFF	**ON**					
PAPER OUT	**ENABLE**	DISABLE					
AUTO CR	**OFF**	ON					
AUTO LF	**OFF**	ON					
COPY MODE	**OFF**	ON					
ENVELOPE	**OFF**	ON					

7242050A

Enter the Initial Settings

1. Insert a Program Disk in the floppy disk drive and turn the instrument's power ON.
2. Ensure that the system reaches the Main Menu without detecting any errors.
3. Set all relevant system settings: date, time, print options, host options and reagent information.
4. Set the customer's IQAP # if it is available.

3.3 INSTRUMENT VERIFICATION

Startup the Instrument

1. Prime the reagent and sweep-flow lines using the **Cycle Reagents** key.
2. Perform the Hgb Preamp and the Vacuum Adjustment procedures (Headings 4.29 and 4.30, respectively).
3. Select **3 STARTUP** and verify proper backgrounds.
4. Perform the Latex Gain Adjustment procedure (Heading 4.27).
5. Set the AIM "target values" (Heading 4.28).
6. Run controls and verify proper system operation. When preparing for calibration, if the control results are not within the stated expectations, adjust the calibration factors to the normal control.

Calibrate the Instrument

Preferably, the trainer performs calibration with the customer as part of customer training. If you (the installer) are also the trainer, you should perform calibration at this time and include the customer.

Calibration must follow the procedure outlined in the Calibration section of the Operator's Guide.

PART B: UPGRADE AND OPTION INSTALLATION

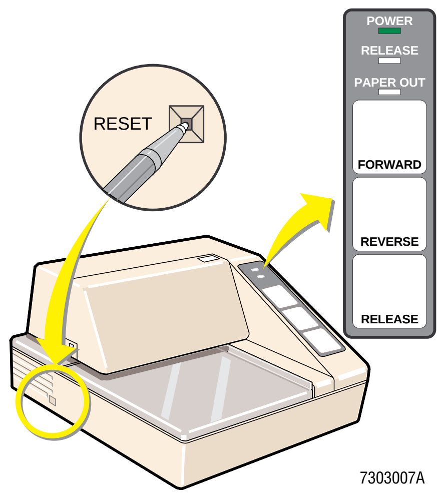
3.4 OPTIONAL TICKET PRINTERS

Epson TM-290P Slip Printer

Purpose

A parallel version of the Epson TM-290P Slip Printer is available for use on the MD II. See Figure 3.4-1.

Figure 3.4-1 Epson TM-290P Slip Printer



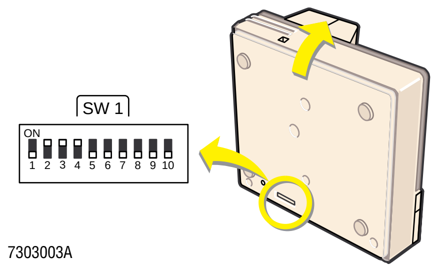
This section contains two procedures. One explains how to install this Ticket Printer instead of a Graphic Printer (Single-Printer Setup) and the other explains how to install this Ticket Printer in conjunction with a Graphic Printer (Two-Printer Setup).

For information on how to use this Printer, see the COULTER MD II Series Analyzer Ticket Printer User's Guide, PN 4237303. For Printer specifications, DIP switch settings and the Printer self-test procedure, see Appendix D.

Single-Printer Setup Procedure

1. Unpack the Ticket Printer. Ensure you have the following components:
   - Printer
   - 24-V printer power supply
   - Line cord for the power supply
   - Standard Centronics® data cable
   - Ticket Key Disk
   - Ribbon ink cassette.
2. Locate the DIP switch, SW1, on the bottom of the Printer sled as shown in Figure 3.4-2. Ensure switch positions 2, 3, and 4 are ON and the rest are OFF. See Table D.1-1 and Table D.1-2 for the switch position functions.

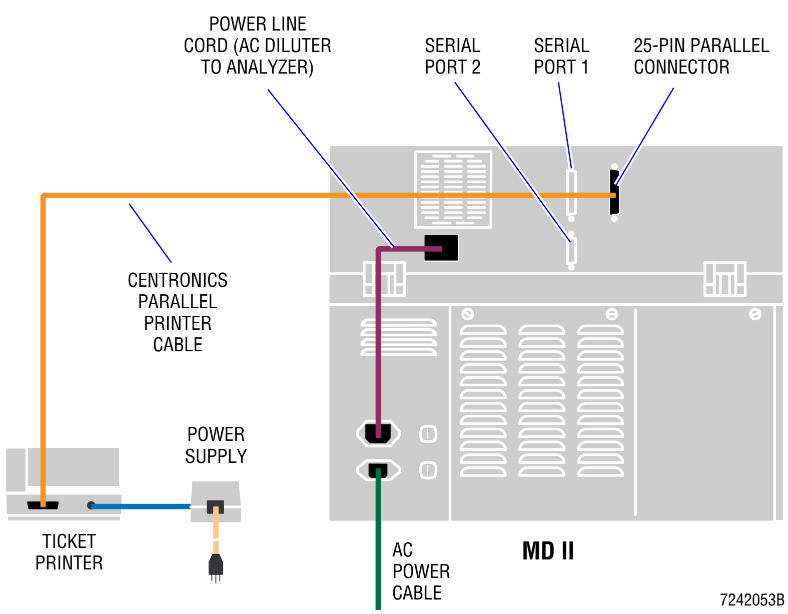
Figure 3.4-2 DIP Switch, SW1, Location



CAUTION Risk of damage to equipment. Turning the instrument's power ON before connecting the Printer to the instrument could damage the instrument. Ensure the power is OFF before connecting the Printer.

3. Ensure the MD II power is off.
4. Connect the Printer as shown in Figure 3.4-3. Connect the power cord last.

Figure 3.4-3 Printer Connections for a Single Printer



5. Perform a Printer self-test on the Ticket Printer as instructed under Heading D.1, EPSON TM-290P SLIP PRINTER, and verify that all the characters print legibly.

6. Turn on the MD II and print the calibration factors to verify that the Printer and instrument are working together.

   Note: The first time the Ticket Printer option is enabled, the instrument will request that you insert the Ticket Key Disk. Once the ticket printer enable is recorded in CMOS, it will not be requested again.

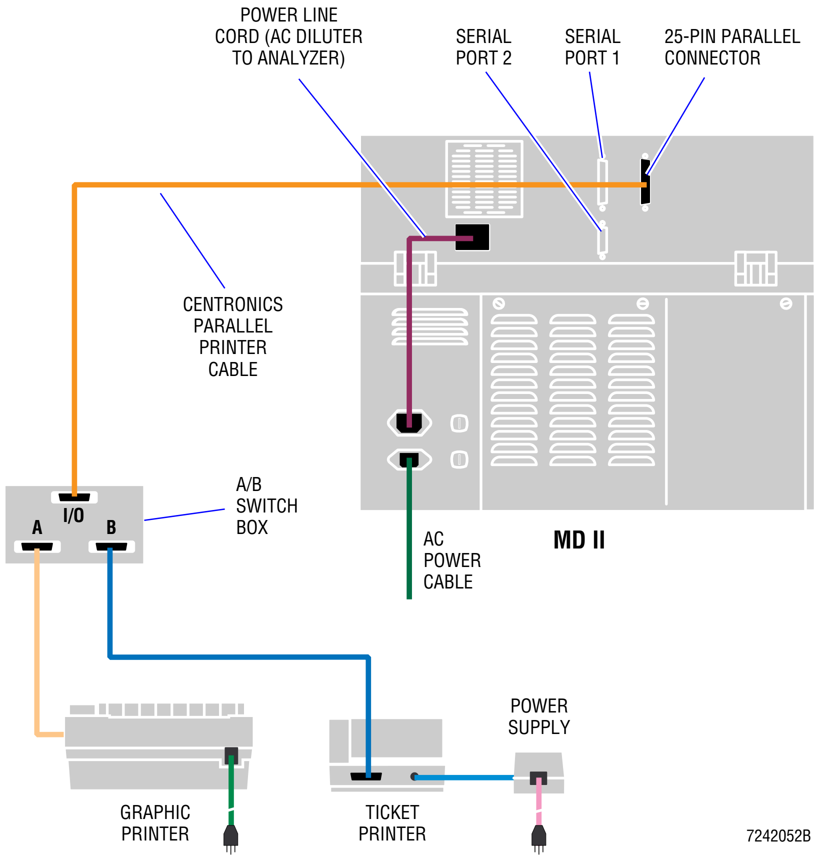
Two-Printer Setup Procedure

1. Unpack the Ticket Printer. Ensure you have the following components:
   - Printer
   - 24-V printer power supply
   - Line cord for the power supply
   - Standard Centronics data cable
   - Ticket Key Disk
   - Ribbon ink cassette.
2. Locate the DIP switch, SW1, on the bottom of the Printer sled as shown in Figure 3.4-2. Ensure switch positions 2, 3, and 4 are ON and the rest are OFF. See Table D.1-1 and Table D.1-2 for the switch position functions for DIP switches SW1 and SW2.
3. Unpack the optional A/B Switch Box. Ensure the A/B Switch Box kit includes:
   - A/B Switch Box
   - 6-ft Centronics cable
   - Installation instructions.

CAUTION Risk of damage to equipment. Turning the instrument's power ON before connecting the Printer to the instrument could damage the instrument. Ensure the power is OFF before connecting the Printer.

4. Ensure the MD II power is off.
5. Using Figure 3.4-4 as a guide, connect:
   a. Graphic Printer to connector A
   b. Ticket Printer to connector B
   c. 6-ft Centronics cable between the I/O connector on the A/B Switch Box and the MD II parallel (Printer) connector
   d. Power cord.
6. Perform a Printer Self-Test on the Ticket Printer as instructed under Heading D.1, EPSON TM-290P SLIP PRINTER, and verify that all the characters print legibly.

Figure 3.4-4 Printer Connections for Two Printers



7. If this is the initial installation of the Graphic Printer:

   a. Load paper into the Graphic Printer.

   b. Set the Printer's configuration for MD II use. Refer to step 3 of the Connect the Printer the Printer procedure under Heading 3.2, INITIAL SETUP.

8. Turn on the MD II and print the calibration factors from both Printers to verify that the Printers and instrument are working together. Since no menu item will set up both Printers at once, use the Printers one at a time as follows:

   - For the Graphic Printer -
     - Select **1 Full Page Report** or **2 Split Page Report** on the Report Format menu
     - Set the A/B Switch Box to A.
   - For the Ticket Printer -
     - Select **3 Ticket Report** on the Report Format menu
     - Set the A/B Switch Box to B.

   Note: The first time the Ticket Printer option is enabled, the instrument will request that you insert the Ticket Key Disk. Once the Ticket Printer enable is recorded in CMOS, it will not be requested again.

4 **SERVICE AND REPAIR PROCEDURES**, 4.1-1

4.1 GUIDELINES, 4.1-1

4.2 ACCESSING THE HIDDEN SERVICE MENU ITEMS, 4.2-1
Accessing Service Report, 4.2-1
Purpose, 4.2-1
Procedure, 4.2-1
Accessing Service Diagnostic, 4.2-1
Purpose, 4.2-1
Procedure, 4.2-1
System Reboot, 4.2-2

4.3 REMOVING THE TOP COVER, 4.3-1

4.4 OPENING THE LOWER CHASSIS, 4.4-1

4.5 AT POWER SUPPLY, 4.5-1
Tools/Supplies Needed, 4.5-1
Removal, 4.5-1
Installation, 4.5-1
Verification, 4.5-2

4.6 AT MOTHERBOARD, 4.6-1
Tools/Supplies Needed, 4.6-1
Removal, 4.6-1
Installation, 4.6-2
Verification, 4.6-3

4.7 SENSOR PROCESSING ADAPTER WITH DIAGNOSTICS (SPAD) CARD, 4.7-1
Tools/Supplies Needed, 4.7-1
Removal, 4.7-1
Installation, 4.7-1
Verification, 4.7-2

4.8 USER RESOURCE ADAPTER (URA) CARD, 4.8-1
Tools/Supplies Needed, 4.8-1
Removal, 4.8-1
Installation, 4.8-2
Verification, 4.8-2

4.9 DILUTER RESOURCE ADAPTER (DRA) 1 AND 2 CARDS, 4.9-1
Tools/Supplies Needed, 4.9-1
Removal, 4.9-1
Installation, 4.9-2
Verification, 4.9-2

4.10 MEMBRANE KEYPAD AND DISPLAY, 4.10-1
Tools/Supplies Needed, 4.10-1
Removal, 4.10-1
Installation, 4.10-2
Verification, 4.10-2

4.11 AC POWER/VACUUM RELAY CARD, 4.11-1
Tools/Supplies Needed, 4.11-1
Removal, 4.11-1
Installation, 4.11-1
Verification, 4.11-2

4.12 +24 VOLT SWITCHING POWER SUPPLY, 4.12-1
Tools/Supplies Needed, 4.12-1
Removal, 4.12-1
Installation, 4.12-2
Verification, 4.12-3

4.13 LINEAR POWER SUPPLY CARD, 4.13-1
Tools/Supplies Needed, 4.13-1
Removal, 4.13-1
Installation, 4.13-2
Verification, 4.13-3

4.14 VACUUM SENSOR CARD, 4.14-1
Tools/Supplies Needed, 4.14-1
Removal, 4.14-1
Installation, 4.14-2
Verification, 4.14-2

4.15 MOTOR/SOLENOID DRIVER CARD, 4.15-1
Tools/Supplies Needed, 4.15-1
Removal, 4.15-1
Installation, 4.15-1
Verification, 4.15-2

4.16 SENSOR PREAMP ADAPTER (SPA) CARD, 4.16-1
Tools/Supplies Needed, 4.16-1
Removal, 4.16-1
Installation, 4.16-2
Verification, 4.16-3

4.17 PROBE AND PROBE WIPE, 4.17-1
Tools/Supplies Needed, 4.17-1
Removal, 4.17-1
Installation, 4.17-2
Verification, 4.17-3

4.18 PROBE MOTOR, 4.18-1
Tools/Supplies Needed, 4.18-1
Removal, 4.18-1
Installation, 4.18-1
Verification, 4.18-1

4.19 TRAVERSE DRIVE BELT, 4.19-1
Tools/Supplies Needed, 4.19-1
Removal, 4.19-1
Installation, 4.19-2
Verification, 4.19-3

4.20 TRAVERSE MOTOR, 4.20-1
Tools/Supplies Needed, 4.20-1
Removal, 4.20-1
Installation, 4.20-2
Verification, 4.20-3

4.21 SYRINGE ASSEMBLY, 4.21-1
Tools/Supplies Needed, 4.21-1
Removal, 4.21-1
Installation, 4.21-3
Verification, 4.21-4

4.22 PERISTALTIC PUMP MOTOR AND SPOOL, 4.22-1
Tools/Supplies Needed, 4.22-1
Removal, 4.22-1
Installation, 4.22-2
Verification, 4.22-2

4.23 VACUUM PUMP, 4.23-1
Tools/Supplies Needed, 4.23-1
Removal, 4.23-1
Installation, 4.23-1
Verification, 4.23-1

4.24 APERTURE, BATH AND APERTURE ELECTRODE MODULE, 4.24-1
Tools/Supplies Needed, 4.24-1
Removal, 4.24-1
Installation, 4.24-2
Verification, 4.24-3

4.25 DILUTER PANEL SOLENOIDS, 4.25-1
Tools/Supplies Needed, 4.25-1
Removal, 4.25-1
Installation, 4.25-1
Verification, 4.25-1

4.26 SWEEP-FLOW TUBING, 4.26-1
Tools/Supplies Needed, 4.26-1
Removal, 4.26-1
Installation, 4.26-2
Verification, 4.26-2

4.27 LATEX GAIN ADJUSTMENT, 4.27-1
Tools/Supplies Needed, 4.27-1
Procedure, 4.27-1

4.28 AIM ADJUSTMENT, 4.28-1
Tools/Supplies Needed, 4.28-1
Procedure, 4.28-1
Optional Procedures, 4.28-1
Option 1, 4.28-1
Option 2, 4.28-2

4.29 HGB PREAMP ADJUSTMENT, 4.29-1
Tools/Supplies Needed, 4.29-1
Procedure, 4.29-1

4.30 VACUUM ADJUSTMENT, 4.30-1
Procedure, 4.30-1

4.31 LYSE VOLUME ADJUSTMENT/VERIFICATION, 4.31-1
Tools/Supplies Needed, 4.31-1
Procedure, 4.31-1

ILLUSTRATIONS

4.3-1 Top View into Upper Chassis, 4.3-1

4.4-1 Top View into Lower Chassis, 4.4-1

4.6-1 Card Removal (AT Motherboard, URA, DRAs and SPAD), 4.6-1
4.6-2 AT Motherboard, 4.6-3

4.8-1 URA Card, 4.8-1

4.9-1 DRA Card, 4.9-1

4.10-1 Membrane Keypad and Display, 4.10-1

4.12-1 +24 V Power Supply, 4.12-1

4.13-1 Linear Power Supply Card, 4.13-1
4.13-2 Back View of MD II with Rear Panel Door Opened, 4.13-2

4.14-1 Vacuum Sensor Card, 4.14-1

4.15-1 Motor/Solenoid Driver Card, 4.15-2

4.16-1 Sensor Preamp Adapter (SPA) Card and Surrounding Components, 4.16-1
4.16-2 Sensor Preamp Adapter Card, 4.16-3

4.17-1 Probe Assembly, 4.17-1

4.19-1 Traverse Drive Belt, 4.19-1

4.20-1 Traverse Motor, 4.20-1

4.21-1 Syringe Assembly, 4.21-2

4.22-1 Peristaltic Pump Motors, 4.22-1

4.24-1 Aperture Bath Assembly, 4.24-1

4.26-1 Sweep-Flow Tubing, 4.26-1

4.1 GUIDELINES

- All the tools and supplies you need to perform a specific procedure are listed under Tools/Supplies Needed, at the beginning of the applicable procedure.
- Each time you are told to turn the instrument's power ON, you should have the Program Disk in the floppy disk drive.
- If you are told to let the system reach the Main Menu and it does not, or you are told to perform a System Verification Procedure (SVP) and the system fails, you will have to troubleshoot the problem. Refer to Chapter 7, Troubleshooting, for guidelines.
- Verify that each connector has a label. Tracing where each connector goes when installing the new card would be very time consuming without labels.

4.2 ACCESSING THE HIDDEN SERVICE MENU ITEMS

There are three service functions hidden (they do not show up on the display) from the customer. They are:

- Service Report
- Service Diagnostic
- System Reboot.

Accessing Service Report

Purpose

Access the Service Report to obtain data about the previous aspirate cycle, whether it was a sample, a control or a calibrator. The Service Report data does not appear on any customer screen or printout. For detailed information on the contents of the Service Report, see Heading 7.2, GENERATING A SERVICE REPORT.

Procedure

To access the Service Report, at the Main Menu select **5 SPECIAL FUNCTIONS ▸▸ 4 SUPERVISOR ▸▸ 7** [no menu item displays on the screen].

A partial report with Aperture Integrity Monitor (AIM) data displays on the screen but does not print unless you have the Auto Print function active. If the Auto Print function is active, a more comprehensive report is automatically sent to the printer.

Accessing Service Diagnostic

Purpose

A Service Diagnostic diluter table (or cycle) is included in the instrument. The table energizes solenoids and motors, one by one. The Service Diagnostic diluter table (Table 7.3-1) is shown in Heading 7.3, SERVICE DIAGNOSTIC.

Procedure

Once you begin the Service Diagnostic, you must advance completely through the table. Pressing **Escape** will not exit the cycle.

1. From the Main Menu, select **5 SPECIAL FUNCTIONS ▸▸ 5 SERVICE ▸▸ 7** [no menu item displays on the screen].
2. When the instrument prompts you for a password, type `123`.

   After entering the password, solenoid LV1, the vacuum transducer vent valve located on the Vacuum Sensor card is energized and the cycle begins.

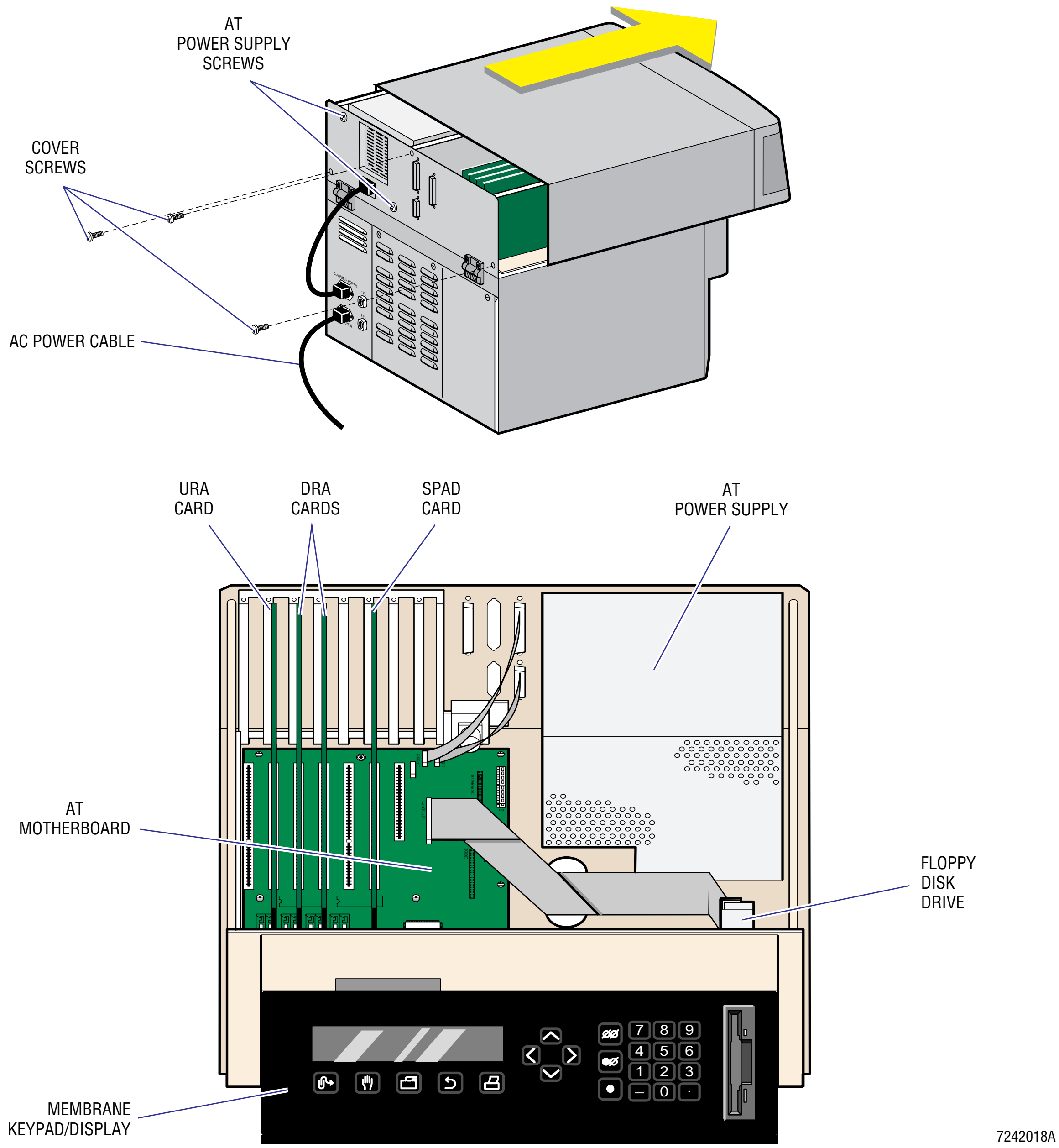
System Reboot

1. Insert the Program Disk.
2. From the Main Menu, select 7 [no menu item displays on the screen].

4.3 REMOVING THE TOP COVER

1. At the rear of the unit, unscrew the three, #2 Phillips-head screws, Figure 4.3-1.
2. Slide the cover off toward the front of the instrument.

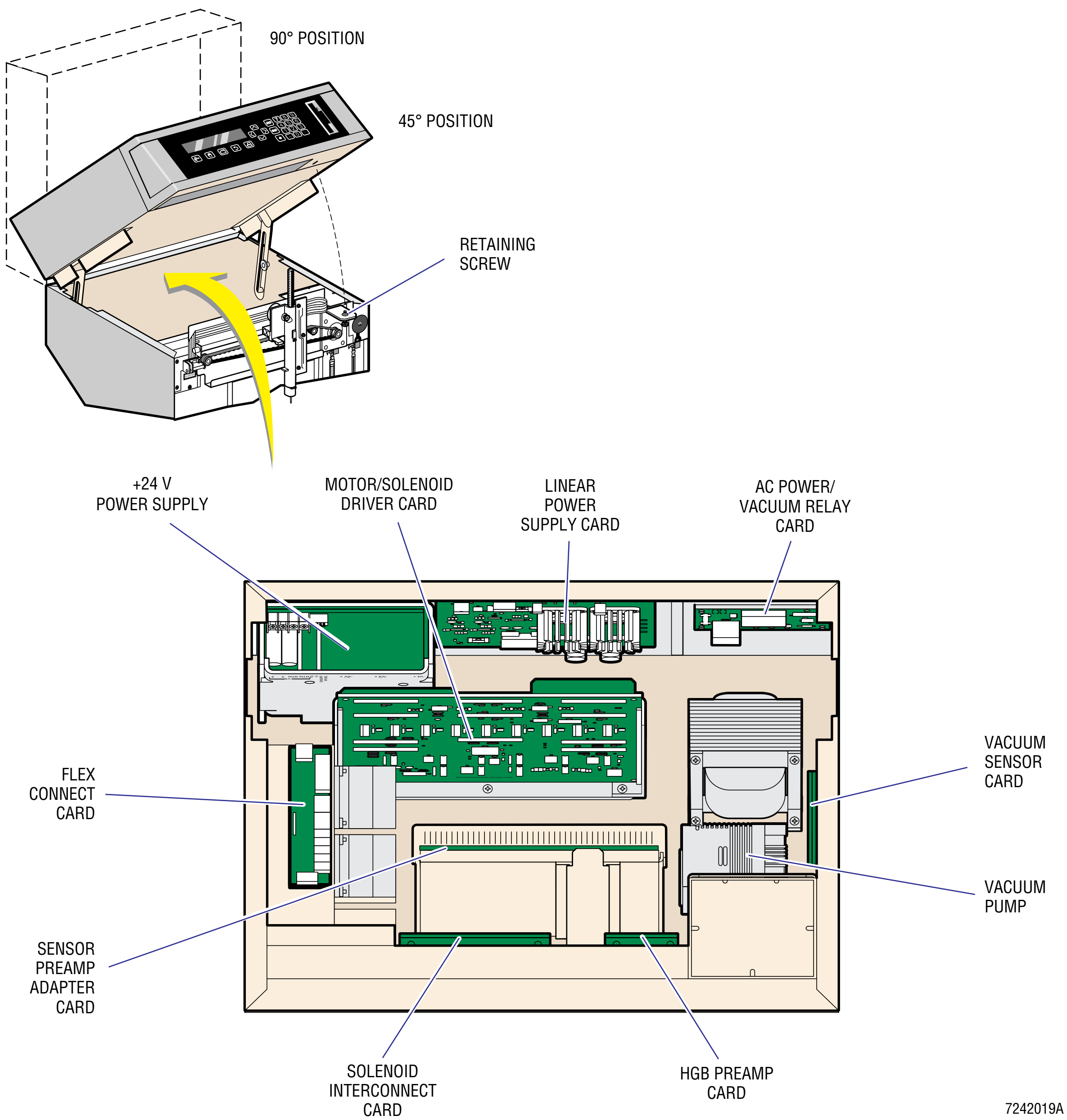
Figure 4.3-1 Top View into Upper Chassis



4.4 OPENING THE LOWER CHASSIS

1. Open the front door of the instrument.
2. Loosen the captive #2 Phillips-head retaining screw just above the traverse motor (Figure 4.4-1).
3. Swing the upper chassis up and back and lock the support arms in place.

Figure 4.4-1 Top View into Lower Chassis



4.5 AT POWER SUPPLY

Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver
- ❑ Voltmeter

Removal

1. Turn OFF the instrument's power.
2. Disconnect the ac power cable from the rear of the power supply (Figure 4.3-1).
3. Remove the top cover as directed under Heading 4.3.
4. Remove electrical connections to the power supply:
   - P1 connects to the floppy disk drive power connector.
   - P2 connects to a cable from the lower chassis terminating at the AC Power/Vacuum Relay card.
   - P4 and P5 connect to the AT motherboard connectors P8 and P9.
5. At the rear of the instrument, remove the two #2 Phillips-head screws holding the power supply to the chassis (Figure 4.3-1).
6. Remove the power supply from the chassis.

Installation

1. Ensure that the input voltage (115 V or 230 V) is set correctly on the new power supply. Use the slide switch just above the ac line connector to set the input voltage.
2. Install the new power supply. The power supply "hooks" into the chassis and must be slid from front to back to properly engage, before fastening screws.
3. At the rear of the instrument, replace the two #2 Phillips-head screws holding the power supply to the chassis (Figure 4.3-1).

CAUTION Risk of electronic damage. If connectors P4 and P5 are attached incorrectly, the motherboard will be damaged. They can only be installed correctly one way. They are, however, identical and could easily be switched. To ensure that P4 and P5 are installed correctly, attach them so that the black wires from each connector are situated together in the middle.

---

4. Connect the power supply to the instrument:
   - P1 connects to the floppy disk drive power connector.
   - P2 connects to a cable from the lower chassis terminating at the AC Power/Vacuum Relay card.
   - P4 and P5 attach to the AT motherboard connectors P8 and P9.
5. Reconnect the ac power cable and turn ON the instrument's power. Wait until the instrument reaches the Main Menu. It is difficult to check power before connecting to the motherboard, since the power supply requires a load before it turns on any supplies, including the power for the fan.

Verification

1. Check voltages at any connector. A label showing a detailed pinout is affixed to the top of the AT power supply and greater detail is also available from the System Interconnect diagram (Chapter 6, Schematics and Block Diagrams). Even without a voltmeter, if the system reaches the Main Menu after power ON, the +5, +12, and -12 V supplies must be present.
   - Red wires are +5 V
   - Yellow wires are +12 V
   - Orange wires are -5 V
   - Blue wires are -12 V.
2. Replace the top cover.
3. Perform an SVP (Heading 5.1).

4.6 AT MOTHERBOARD

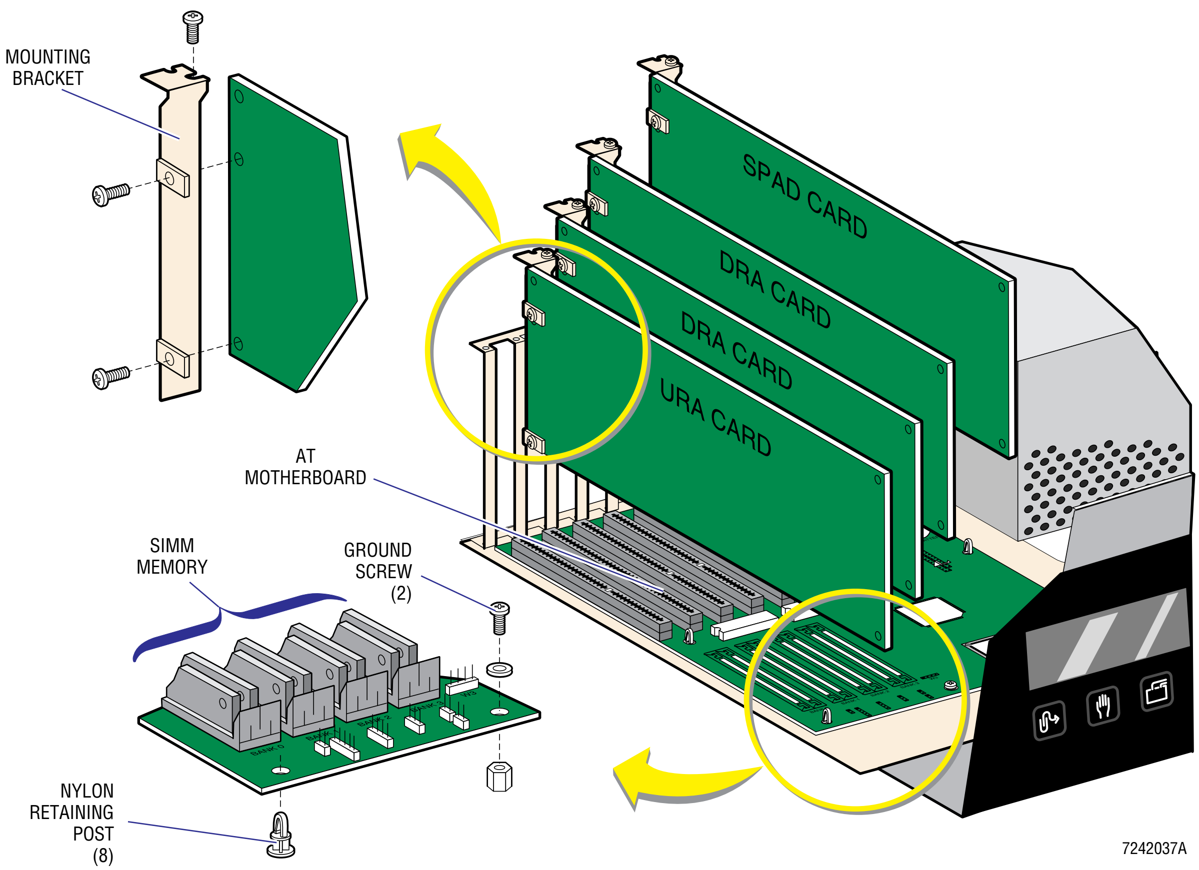
Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver

Removal

1. Turn OFF the instrument's power.
2. Disconnect the ac power cable from the rear of the power supply (Figure 4.3-1).
3. Remove the top cover as directed under Heading 4.3.
4. Remove the SPAD card (Heading 4.7), the URA card (Heading 4.8) and the two DRA cards (Heading 4.9) shown in Figure 4.6-1.
5. Disconnect P4 and P5 of the AT power supply from P8 and P9 on the AT motherboard.

Figure 4.6-1 Card Removal (AT Motherboard, URA, DRAs and SPAD)



6. Disconnect the floppy disk drive, the external interface cables and the speaker:
   - Floppy disk drive connects to J17.
   - Serial 1 port connects to J15.
   - Serial 2 port connects to J14.
   - Parallel (Printer) port connects to J18.
   - Speaker port connects to J22.
7. Remove the two motherboard ground screws (Figure 4.6-2).
8. Remove the nylon retaining posts (Figure 4.6-1):
   a. Start at one end and work to the other.
   b. Squeeze the nylon retaining posts while lifting the AT motherboard, until the card can be completely removed.

Installation

1. Press the new motherboard onto the nylon retaining posts and attach the two ground screws.
2. Verify the proper switch and jumper settings (Figure 4.6-2).
3. Verify that the SIMM memory is in place and properly seated (Figure 4.6-1).
4. Connect the external interface cables, the speaker and the floppy disk drive (Figure 4.6-2):
   - Serial 1 port connects to J15.
   - Serial 2 port connects to J14.
   - Parallel (Printer) port connects to J18.
   - Speaker port connects to J22.
   - Floppy disk drive connects to J17.

CAUTION Risk of electronic damage. If connectors P4 and P5 are attached incorrectly, the motherboard will be damaged. They can only be installed correctly one way. They are, however, identical and could easily be switched. To ensure that P4 and P5 are installed correctly, attach them so that the black wires from each connector are situated together in the middle.

---

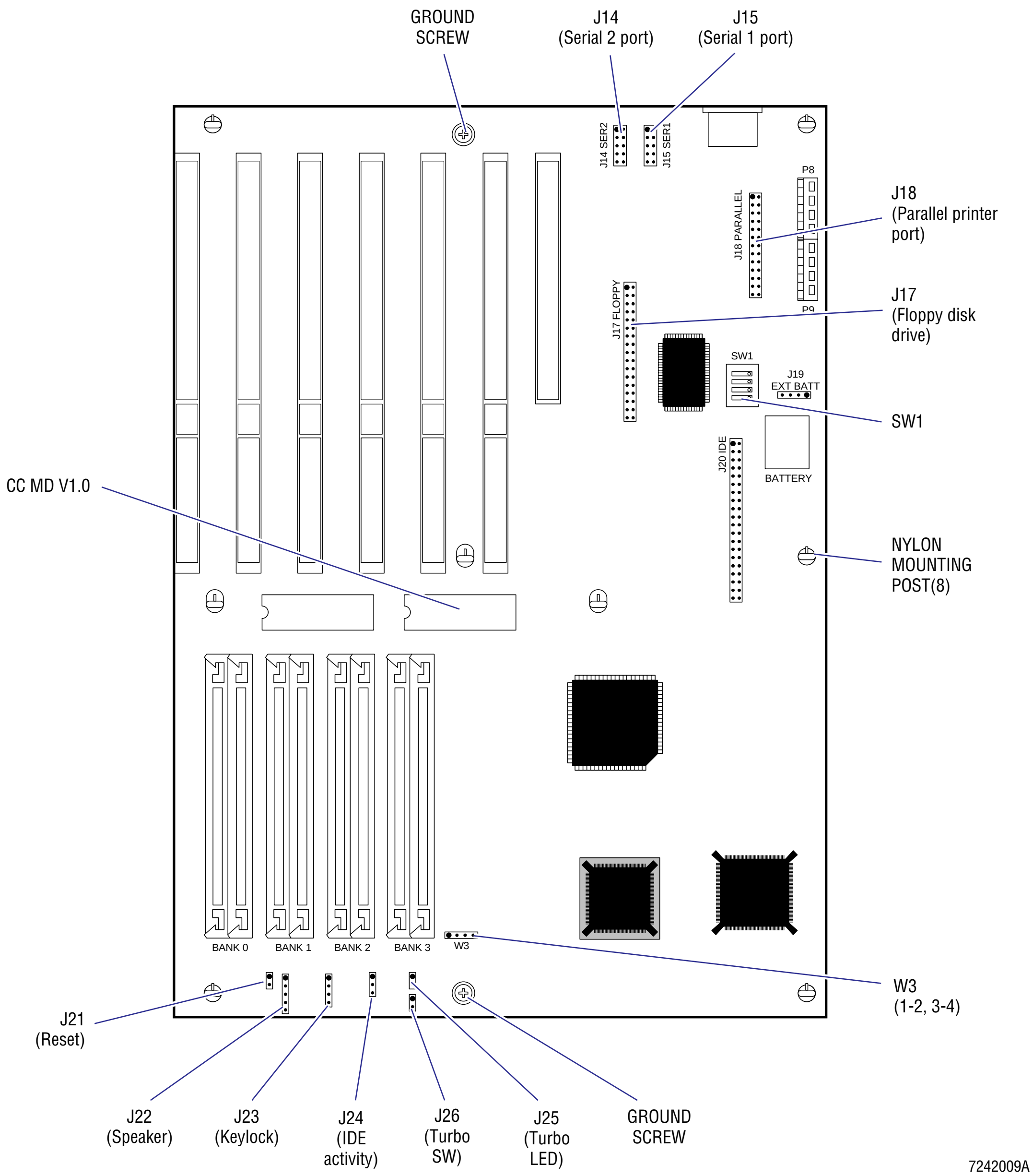
5. Connect P4 and P5 of the AT power supply to J8 and J9 on the motherboard.
6. Install the SPAD (Heading 4.7), URA (Heading 4.8) and both DRA (Heading 4.9) cards.
7. Replace the top cover.
8. Reconnect the ac power cable.

Verification

Without a keyboard and monitor the best way to verify AT motherboard operation is to use the instrument.

1. Turn ON the instrument's power and check to see that the system reaches the Main Menu. This tells you that you have successfully:
   - Passed BIOS POST
   - Booted
   - Read from the floppy disk drive
   - Executed a program
   - Communicated with all four cards plugged into the bus.

Figure 4.6-2 AT Motherboard



2. Verify the ability to write to the floppy disk drive by temporarily changing a configuration item, such as a host or Printer option. This forces the system to write the new configuration to disk. If no problem is observed, restore the system to its original configuration.
3. Verify the operation of the Printer port by printing a configuration item such as the calibration factors.
4. If the customer uses a host computer, have a sample sent to the host to verify Serial 1 port operation.
5. Perform an SVP (Heading 5.1).

4.7 SENSOR PROCESSING ADAPTER WITH DIAGNOSTICS (SPAD) CARD

Tools/Supplies Needed

- ❑ #1 Phillips-head screwdriver
- ❑ #2 Phillips-head screwdriver

Removal

1. Turn OFF the instrument's power.
2. Remove the top cover as directed under Heading 4.3.
3. Locate the SPAD card (Figure 4.3-1).
4. Remove the screw that fastens the card's metal-mounting bracket to the rear of the chassis by using a #1 Phillips-head screwdriver (Figure 4.6-1).
5. Remove all the cables connected to the card (J1 through J4, J8 and J9). Note where each goes for ease of installation.
6. Remove the SPAD card.

Installation

1. On the new SPAD card, verify that jumper X7 is ON.
2. Install the SPAD card into the rightmost (facing the instrument), 16-bit slot (Figure 4.6-1).
3. Reconnect the card's metal-mounting bracket to the rear of the chassis with the Phillips-head screw (Figure 4.6-1).
4. Reconnect the cables:
   - J1, J2, J3 take coaxial cables from the Sensor Preamp Adapter card carrying the PLT, RBC and WBC signals, respectively.
   - J4 (from the Sensor Preamp Adapter card) is a 4-pin connector.
   - J5 is present but is unused at this time.
   - J8 (from the Linear Power Supply card) is a large 10-pin connector.
   - J9 (RBC and WBC AIM voltage to the URA card).
5. Replace the top cover.
6. Turn ON the instrument's power.

Verification

1. From the Main Menu, select **5 SPECIAL FUNCTIONS ▸▸ 5 SERVICE ▸▸ 3 PULSE TEST**.
2. Verify that the results match the expected results.
3. Perform an SVP (Heading 5.1) making sure the histograms display as expected.

4.8 USER RESOURCE ADAPTER (URA) CARD

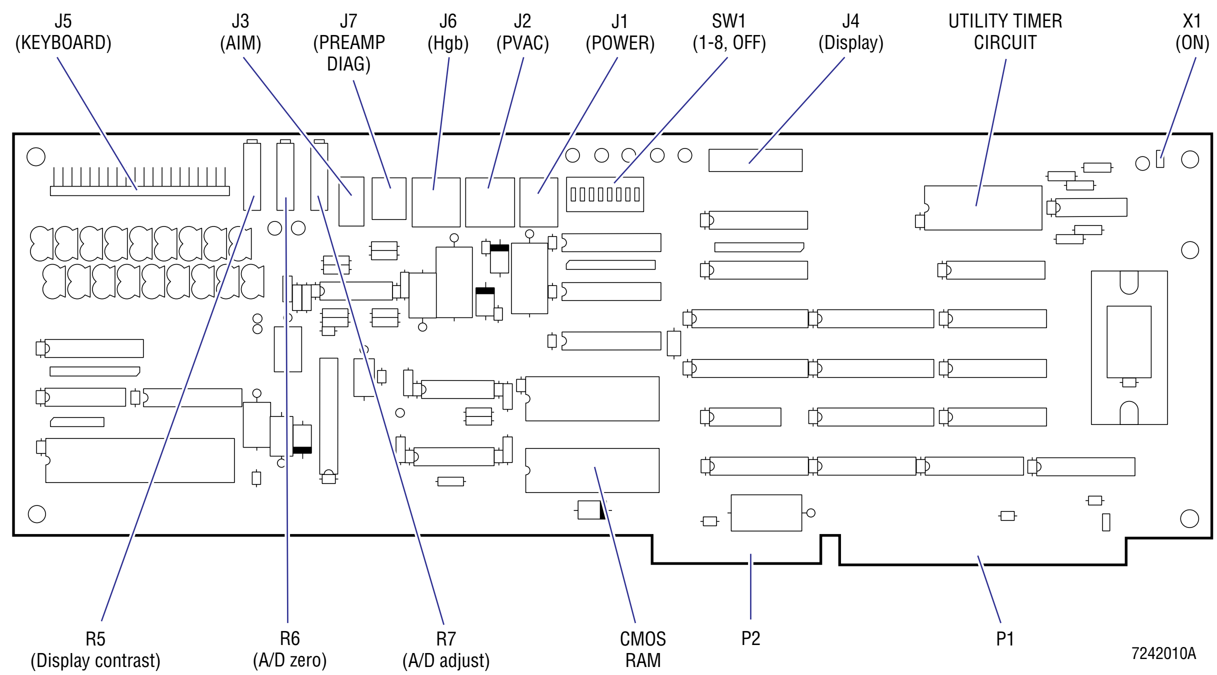
Tools/Supplies Needed

- ❑ #1 Phillips-head screwdriver
- ❑ #2 Phillips-head screwdriver

Removal

1. Turn OFF the instrument’s power.
2. Disconnect the ac power cable.
3. Remove the top cover as directed under Heading 4.3.
4. Locate the URA card (Figure 4.3-1).
5. Remove the screw that fastens the card's metal mounting bracket to the rear of the chassis by using a #1 Phillips-head screwdriver.
6. Remove the seven cables connected to the card (J1 through J7).
7. Remove the URA card.

Figure 4.8-1 URA Card



Installation

1. On the new URA card, Figure 4.8-1, verify that:
   - Jumper X1 is ON
   - All eight positions of switch SW1 are OFF.
2. Install the URA card into the second, 16-bit expansion slot from the left (facing the instrument).
3. Replace the screw that fastens the card's metal mounting bracket to the rear of the chassis by using a #1 Phillips-head screwdriver (Figure 4.6-1).
4. Reconnect cables J1 through J7 to the card:
   - J1 - supplies power to the linear supply in the lower chassis.
   - J2 - the vacuum voltage from the Vacuum Sensor card.
   - J3 - the AIM voltage from the SPAD card.
   - J4 - a ribbon cable going to the LCD screen.
   - J5 - a flex cable coming from the keypad.
   - J6 - Hgb preamp.
   - J7 - the preamp diagnostics voltages.
5. Replace the top cover.
6. Reconnect the ac power cable.

Verification

There are five functions of the URA card that need to be verified. The two most important functions, interfacing the display and the keypad, can be checked by running a cycle. Going through various menus will make use of many keys as well.

1. Turn ON the instrument's power and allow the system to reach the Main Menu. During power ON, two voltage checks are made. If no errors display, the A/D converter is operating properly.
2. Use various items to check the display and keypad. For example, verify that the display and keypad are operating properly by inputting a 10-digit Sample ID at the Main Menu.
3. Go through all the screens in the Setup menu and make sure that they match the customers settings. From the Main Menu, select **5 SPECIAL FUNCTIONS ▸▸ 1 SETUP**.

   Note: There is CMOS RAM (Figure 4.8-1) on the URA card containing all the customer's configuration settings (Printer options, control options, and host settings). If the new URA CMOS memory is clear, and the system booted with the same disk that the customer was using, the settings will match. Any other set of circumstances will produce different settings. For more information on what could happen with these settings, see the description of the URA card in Heading 2.4.
4. With a sample running, verify that the "running marker" in the upper-right corner of the display is "rotating." This makes use of the Utility Timer circuit on the URA card.
5. Perform an SVP (Heading 5.1).

4.9 DILUTER RESOURCE ADAPTER (DRA) 1 AND 2 CARDS

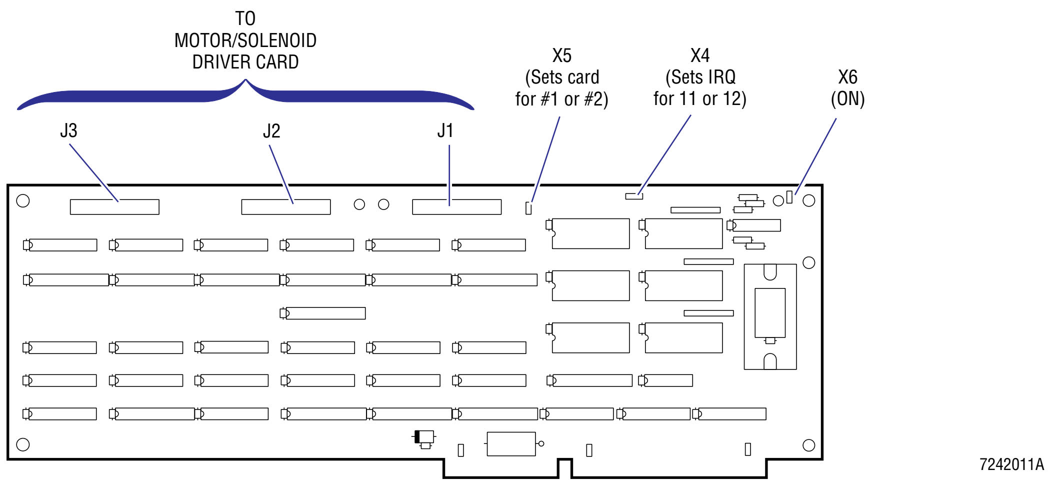
Tools/Supplies Needed

- ❑ #1 Phillips-head screwdriver
- ❑ #2 Phillips-head screwdriver

Removal

1. Turn OFF the instrument's power.
2. Remove the top cover as directed under Heading 4.3.
3. Locate the DRA card(s) you are replacing (Figure 4.6-1).
4. Remove the screw that fastens the card's metal mounting bracket to the rear of the chassis by using a #1 Phillips-head screwdriver (Figure 4.6-1).

Figure 4.9-1 DRA Card



5. Remove the three ribbon cables (P1, P2, P3) connected to the Motor/Solenoid Driver card and the AIM voltage cable connecting the SPAD card to the URA card.
6. Remove the DRA card(s).

Installation

1. On the new DRA card(s), verify all the jumper settings (Figure 4.9-1):
   - X6 - use for both DRA cards.
   - DRA1 - X5 ON and X4 jumpered for IRQ11.
   - DRA2 - X5 OFF and X4 jumpered for IRQ12.
2. Install DRA card(s). DRA1 goes into the fourth, 16-bit expansion slot from the left (facing the instrument) and DRA2 goes into the third, 16-bit expansion slot from the left (Figure 4.6-1).
3. Replace the screw that fastens the card's metal mounting bracket to the rear of the chassis by using a #1 Phillips-head screwdriver (Figure 4.6-1).
4. Reconnect the three ribbon cables (P1, P2, P3) to the Motor/Solenoid Driver card and the AIM voltage cable connecting the SPAD card to the URA card.
5. Replace the top cover.

Verification

1. Turn ON the instrument's power.
2. Observe that both syringes operate while the system is powering up.
3. Verify the operation of all the solenoid valves and the Traverse Assembly mechanism by using the Service Diagnostic as directed under Heading 4.2.
4. Verify the operation of the peristaltic pumps:
   a. From the Main Menu, select **5 SPECIAL FUNCTIONS ▸▸ 3 DILUTER FUNCTIONS**.
   b. Select **4 RINSE** to check PM3.
   c. Select **3 DRAIN** to check PM4.
   d. Select **5 MIX** to check PM1.
   e. Select **4 RINSE** several times, until reservoir must refill, to check PM2.
5. Perform an SVP (Heading 5.1).

4.10 MEMBRANE KEYPAD AND DISPLAY

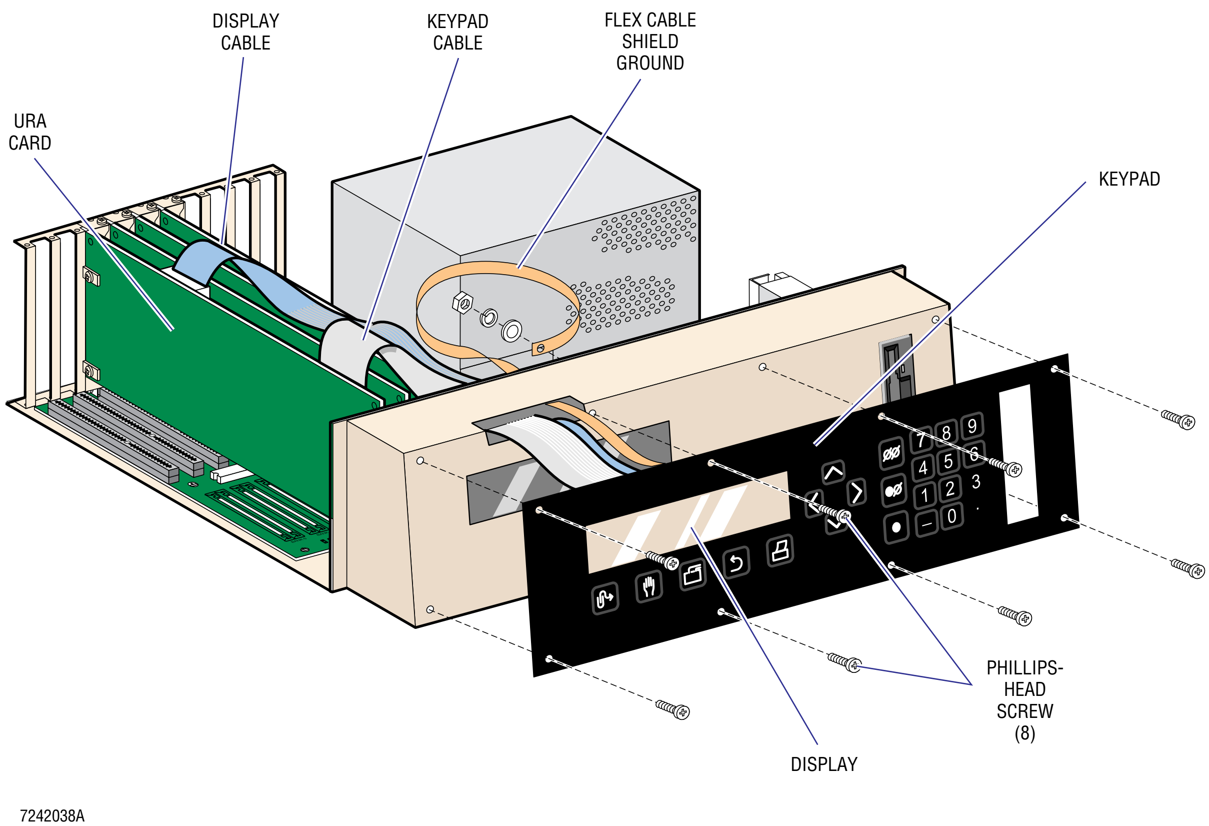
Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver
- ❑ 1/4 in. nut driver

Removal

1. Turn OFF the instrument's power.
2. Remove the top cover as directed under Heading 4.3.
3. Disconnect the following cables (Figure 4.10-1):
    a. The display cable (ribbon) from J4 on the URA card.
    b. The keypad cable (flex) from J5 on the URA card.
    c. The keypad flex cable shield ground from its connection post on the chassis.
4. Remove the eight, #2 Phillips-head screws that fasten the keypad/display assembly to the chassis (Figure 4.10-1).

Figure 4.10-1 Membrane Keypad and Display



5. Remove the keypad/display assembly from the chassis, being careful not to snag one of the connectors as you pull the cables through the chassis opening (Figure 4.10-1).

6. Remove the four KEPS nuts and four flat washers (on the back of the display) that fasten the display to the keypad.
7. Remove the display, being careful not to lose any of the four spacers underneath it.

Installation

1. Fasten the new display and keypad together:
    a. Place the spacer hardware on each threaded post.
    b. Install the display on the posts.
    c. Place a flat washer on each post.
    d. Thread the KEPS nut.
2. Feed the three cables through the chassis opening, being careful not to snag one of the connectors as you pull the cables through the chassis opening (Figure 4.10-1).
3. Fasten the keypad/display assembly to the chassis with the eight, #2 Phillips-head screws.
4. Reconnect the cables (Figure 4.10-1):
    a. The display cable (ribbon) to J4 on the URA card.
    b. The keypad cable (flex) to J5 on the URA card.
    c. The keypad flex cable shield ground to its connection post on the chassis.

    Note: Make sure that these cables do not interfere with the travel of the traverse rack.
5. Replace the top cover and turn ON the instrument's power.

Verification

1. Navigate through the instrument's menus, and run a sample cycle to verify the operation of all the keypad switches.
2. Observe the display and check for any problems with the visual output, as you check the operation of the keypad switches.
3. If no problems are observed, perform an SVP (Heading 5.1).

4.11 AC POWER/VACUUM RELAY CARD

Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver

Removal

1. Turn OFF the instrument's power.

WARNING Risk of personal injury. There is a shock hazard if the power cord is not disconnected. Unplug the ac power cable.

---

2. Disconnect the ac power cable.
3. Open the lower chassis as directed under Heading 4.4 and locate the AC Power/Vacuum Relay card (Figure 4.4-1).
4. Disconnect the six wiring connections (P1 through P5 and P7). Several are the same, so make sure they are properly labeled to facilitate reconnecting them to the replacement card.
5. Remove the card by pulling it off the posts. The card is fastened using four snap-on posts.

Installation

1. Remove the voltage selection connector/jumper P6 from J6 and install it on the replacement card.
2. Verify that the on-card fuse is in place and is 1/4 A.
3. Snap the replacement AC Power/Vacuum Relay card in place.
4. Connect the six wiring connectors. P1 through P5 and P7 attach to J1 through J5 and J7, respectively.
5. Close the lower chassis.
6. Reconnect the ac power cable.

Verification

1. Turn ON the instrument's power.
2. Wait for the system to reach the Main Menu. This verifies the operation of relay K2.

   Note: Power tests are performed during the power-up cycle to verify the +24 V power supply and the Linear Power Supply card voltages. If the tests are passed, the K2 relay is working properly.
3. Verify relay K1 operation by either listening for the vacuum pump to turn on during self-test or doing a Vacuum Adjustment procedure (Heading 4.30) to turn on the vacuum pump.
4. Perform an SVP (Heading 5.1).

4.12 +24 VOLT SWITCHING POWER SUPPLY

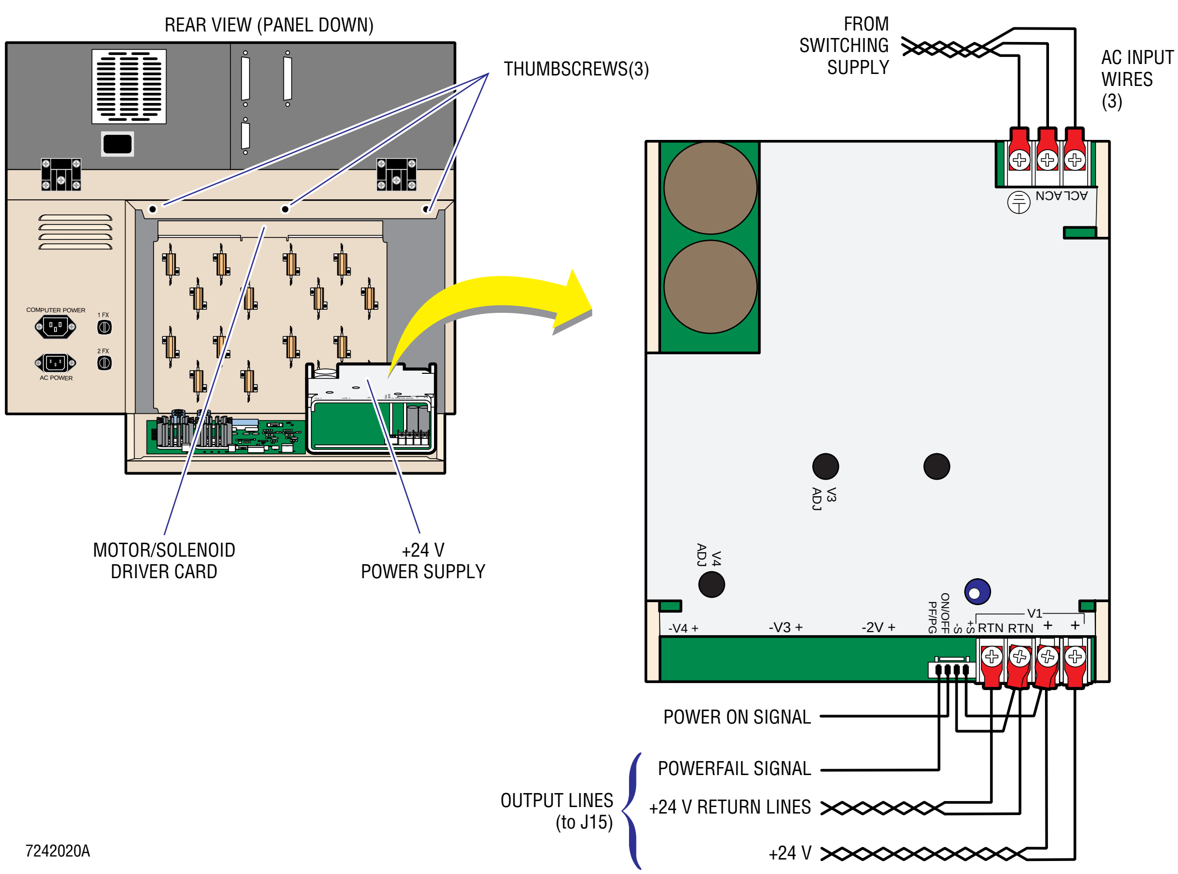
Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver
- ❑ Large flat-blade screwdriver

Removal

1. Turn OFF the instrument's power.
2. Disconnect the ac power cable.
3. At the rear of the instrument, loosen the three captive thumbscrews (Figure 4.12-1) at the top of the rear panel drop-down door. These thumbscrews are recessed and may require the use of a large flat-blade screwdriver.

Figure 4.12-1 +24 V Power Supply



4. Drop down the rear panel.
5. Disconnect the three ac input wires from the power supply. They are attached to a three-position terminal strip (Figure 4.12-1).

6. Disconnect the output and signal wires (Figure 4.12-1). The new part should include a harness with this wiring attached.
    a. If the harness **is included**, open up the lower chassis to gain access to the front of the Motor/Solenoid Driver card and disconnect P15. Some wire wraps may also have to be cut to release the harness.
    b. If the harness **is not included**, disconnect the wires going to the four-position terminal strip and remove the four-pin connector beside the terminal strip.
        1) Disconnect the three red wires, two from the Motor/Solenoid Driver card and one from the (+S) on the four-wire connector from the two (+) terminals.
        2) Disconnect the three black wires, two from the Motor/Solenoid Driver card and one from the (-S) on the four-wire connector from the two (RTN) terminals.
7. Remove the power supply. The power supply is held on with four, #2 Phillips-head screws accessed from the backside of the rear panel.

Installation

1. Attach the new +24 V power supply to the rear panel using the four Phillips-head screws.
2. Connect the three ac input wires that are attached to a three-position terminal strip (Figure 4.12-1):
    - The brown line (hot wire) connects to ACL.
    - The blue return line connects to ACN.
    - The green/yellow stripe wire connects to ground.
3. If the output wiring harness has been provided with the supply, open the lower chassis to gain access to the front of the Motor/Solenoid Driver card and connect P15 to J15.
4. If the output wiring harness has **not** been provided, connect the four-position plug. It only goes on one way and has the power ON/OFF, powerfail (PF/PG), and output sense lines.
5. Connect the output lines to the four-position terminal strip (Figure 4.12-1):
    a. Connect the three red wires, two from the Motor/Solenoid Driver card and one from the (+S) on the four-wire connector to the two (+) terminals.
    b. Connect the three black wires, two from the Motor/Solenoid Driver card and one from the (-S) on the four-wire connector to the two (RTN) terminals.
6. Close the rear panel.
7. Reconnect the ac power cable.

Verification

1. Turn ON the instrument's power and allow the system to reach the Main Menu. This verifies the operation of the +24 V power supply.

   Note: The +24 V turns on when the system software is loaded. An error is displayed on the screen (*ERROR DETECTED (015) Power Supply Failure*) if there is no +24 V, and the Main Menu is never displayed on the screen. Since this power supply has regulating sense lines, it self-adjusts, checking and adjusting with a voltmeter is unnecessary. If the power supply is unable to attain +24 V, it signals the instrument that there is a problem and *ERROR DETECTED (015) Power Supply Failure* is displayed on the screen.

2. Perform an SVP (Heading 5.1).

4.13 LINEAR POWER SUPPLY CARD

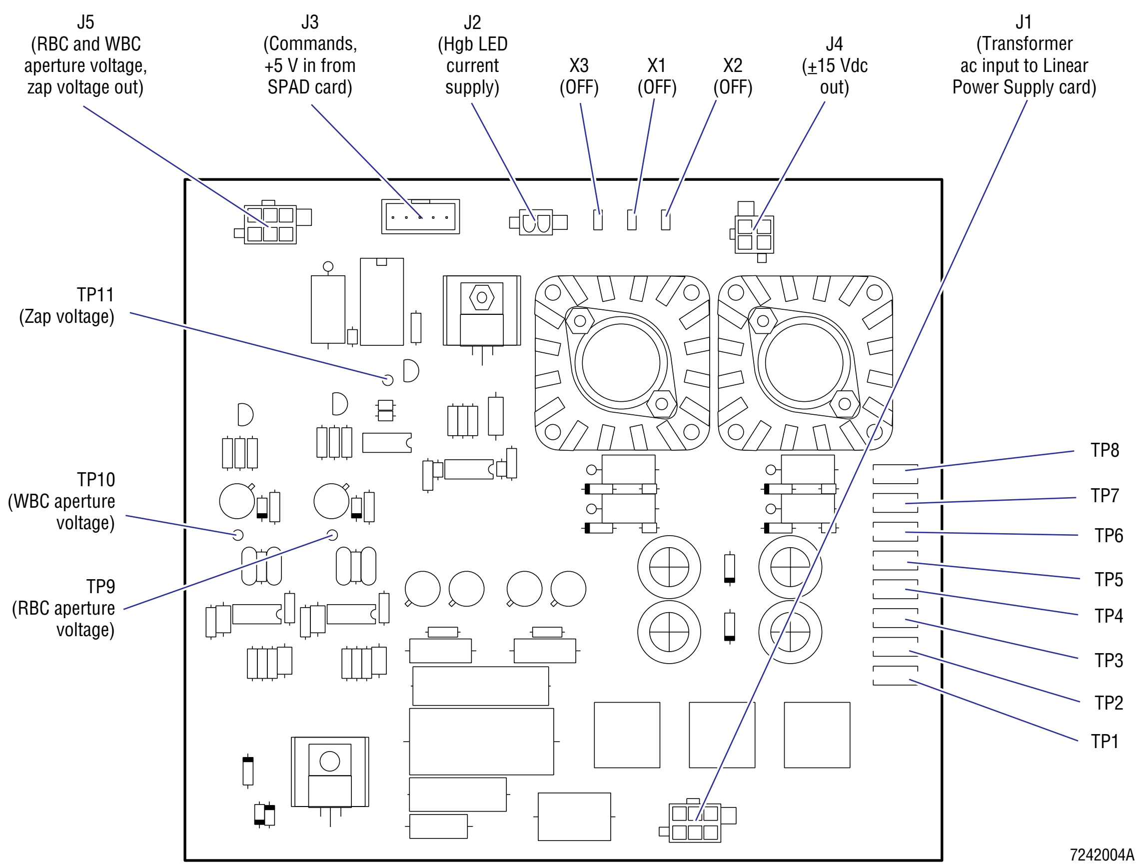
Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver
- ❑ Large flat-blade screwdriver
- ❑ Voltmeter

Removal

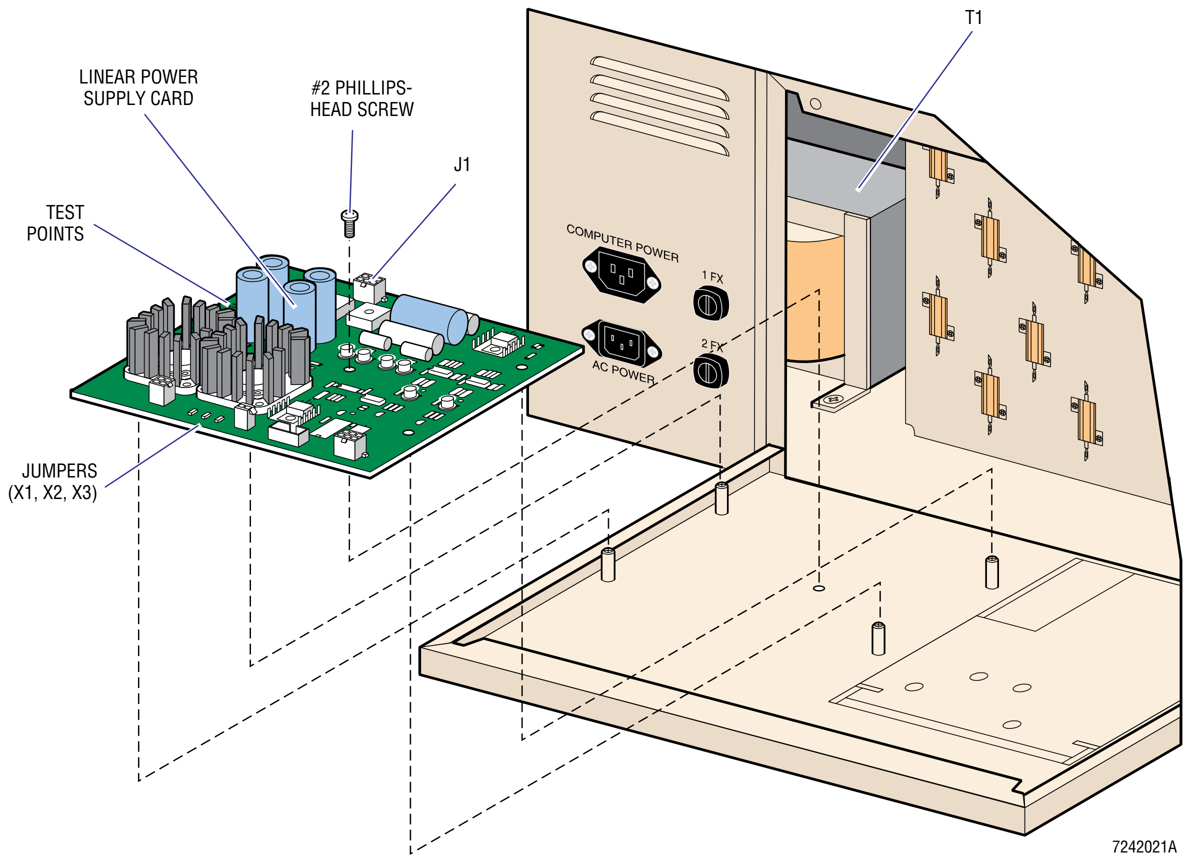
1. Turn OFF the instrument's power.
2. Disconnect the ac power cable.
3. At the rear of the instrument, loosen the three captive thumbscrews at the top of the rear panel drop-down door. These thumbscrews are recessed and may require the use of a large flat-blade screwdriver (Figure 4.12-1).
4. Drop down the rear panel.
5. Electrically disconnect the Linear Power Supply card from the system. There are five connectors (Figure 4.13-1) to remove from the card (J1 through J5).

Figure 4.13-1 Linear Power Supply Card



6. Remove the card from the rear panel, Figure 4.13-2:
   a. Remove the #2 Phillips-head screw in the center of the card.
   b. Pull the card off its four snap-type mounting posts.

Figure 4.13-2 Back View of MD II with Rear Panel Door Opened



Installation

1. On the new Linear Power Supply card, verify that jumpers X1, X2, and X3 are OFF (Figure 4.13-2).
2. Install the new Linear Power Supply card, securing it with the #2 Phillips-head screw (Figure 4.13-2).
3. Connect P1 (from transformer T1) to J1 (on the Linear Power Supply card), see Figure 4.13-2.
4. Reconnect the ac power cable.

Verification

1. Turn ON the instrument's power. The Linear Power Supply card should produce voltages immediately.

ATTENTION: The Linear Power Supply card is grounded to the Sensor Preamp Adapter card. Since the Sensor Preamp Adapter card is not yet connected, you must use the associated black reference test point with each voltage test point to get a proper reading.

2. Using your voltmeter, verify that you have:
   - +15 Vdc ±0.75 V
   - -15 Vdc ±0.75 V
   - +240 Vdc ±24 V.
3. Turn OFF the instrument's power.
4. Connect the four output connectors. P2 through P5 connect to J2 through J5, respectively.
5. Turn ON the instrument's power.
6. Measure the Hgb LED current supply by connecting the voltmeter negative lead to TP7 (CATHODE) and the positive lead to TP8 (ANODE), Figure 4.13-1. It should measure approximately 2.2 Vdc.

   Note: This voltage is dependent on other components and does not have a specific stated range.
7. Close the rear panel door and replace the three captive thumbscrews.
8. Verify that the system reached the Main Menu. If it did not, turn the instrument's power OFF then back ON again.
9. Verify that the Hgb voltage is between 3.5 and 4.5 V by performing the Hgb Preamp Adjustment procedure as directed under Heading 4.29.
10. Perform an SVP (Heading 5.1).

4.14 VACUUM SENSOR CARD

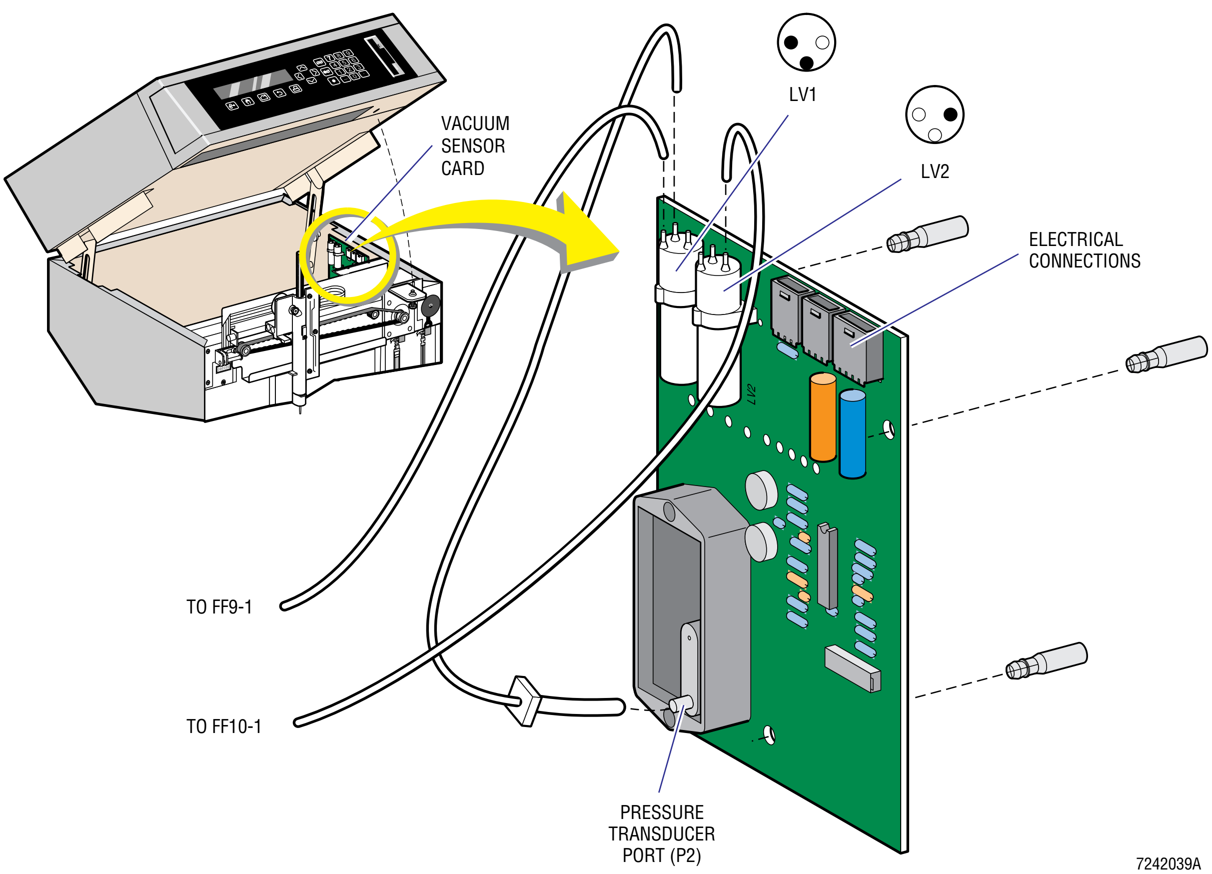
Tools/Supplies Needed

- ❑ Needle-nose pliers
- ❑ #2 Phillips-head screwdriver

Removal

1. Turn OFF the instrument's power.
2. Disconnect the ac power cable.
3. Open up the lower chassis as directed under Heading 4.4 and locate the Vacuum Sensor card (Figure 4.4-1). It is preferable to open the chassis door a full 90 degrees.
4. Remove the card by pulling it off the three snap-on posts, Figure 4.14-1, and out of the lower chassis as far as the wires and tubing will allow. The card snaps onto three snap-on posts.

Figure 4.14-1 Vacuum Sensor Card



5. Disconnect the three electrical connectors J1, J2, J3.
6. Remove the two tubes coming from the VIC that attach to solenoids LV1 (from FF 9-1) of the normally open port and LV2 (from FF 10-1) of the normally closed port (Figure 4.14-1).

   Note: Marking these lines before disconnecting them will save having to trace them back on installation.
7. Remove the tubing and adapters connecting pressure transducer port P2 and the common port of LV1 (Figure 4.14-1).

Installation

1. Connect the tubing from the common port of LV1 to port P2 of the pressure transducer (Figure 4.14-1). Use new tubing if replacement looks necessary.
2. Connect the tubing that traces back to a Y-fitting (FF 9-1), to the normally open port of LV1 (Figure 4.14-1).
3. Connect the tubing that eventually traces back to a Y-fitting (FF 10-1), then a fluid barrier, to the normally closed port of LV2 (Figure 4.14-1).
4. Connect the electrical connectors (Figure 4.14-1):
   - P1 to J1
   - P2 to J2
   - P3 to J3.
5. Install the new Vacuum Sensor card onto its three snap-on posts (Figure 4.14-1).
6. Close the upper chassis.
7. Reconnect the ac power cable.
8. Turn ON the instrument's power.

Verification

1. Perform the Vacuum Adjustment procedure (Heading 4.30). If no adjustment is needed, misadjust and readjust to verify that the Vacuum Sensor tracks vacuum changes.
2. Perform an SVP (Heading 5.1).

4.15 MOTOR/SOLENOID DRIVER CARD

Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver

Removal

1. Turn OFF the instrument's power.
2. Disconnect the ac power cable.
3. Open the lower chassis as directed under Heading 4.4 and locate the Motor/Solenoid Driver card (Figure 4.4-1).
4. Remove the Phillips-head shipping screw from the card, if it is still present. This screw, located in the upper left portion of the card just below connector J18 and accessed from the rear, does not need to be reused once the instrument is installed.
5. Slide the card partially out of the unit. While easily accessible, remove connectors P7, P8, P11, and P10.
6. Slide the card all the way down and remove the remaining connectors (P6, P2, P3, P15, P18, P4, P23, P5 and P1).
   a. Remove connectors in a top-down manner and lift the card as they are removed.
   b. Verify that each connector is labeled. If not, label at this time.

      Note: Tracing where each connector goes when installing the new card would be very time consuming without labels.
7. Slide the card up and out, it is not attached.

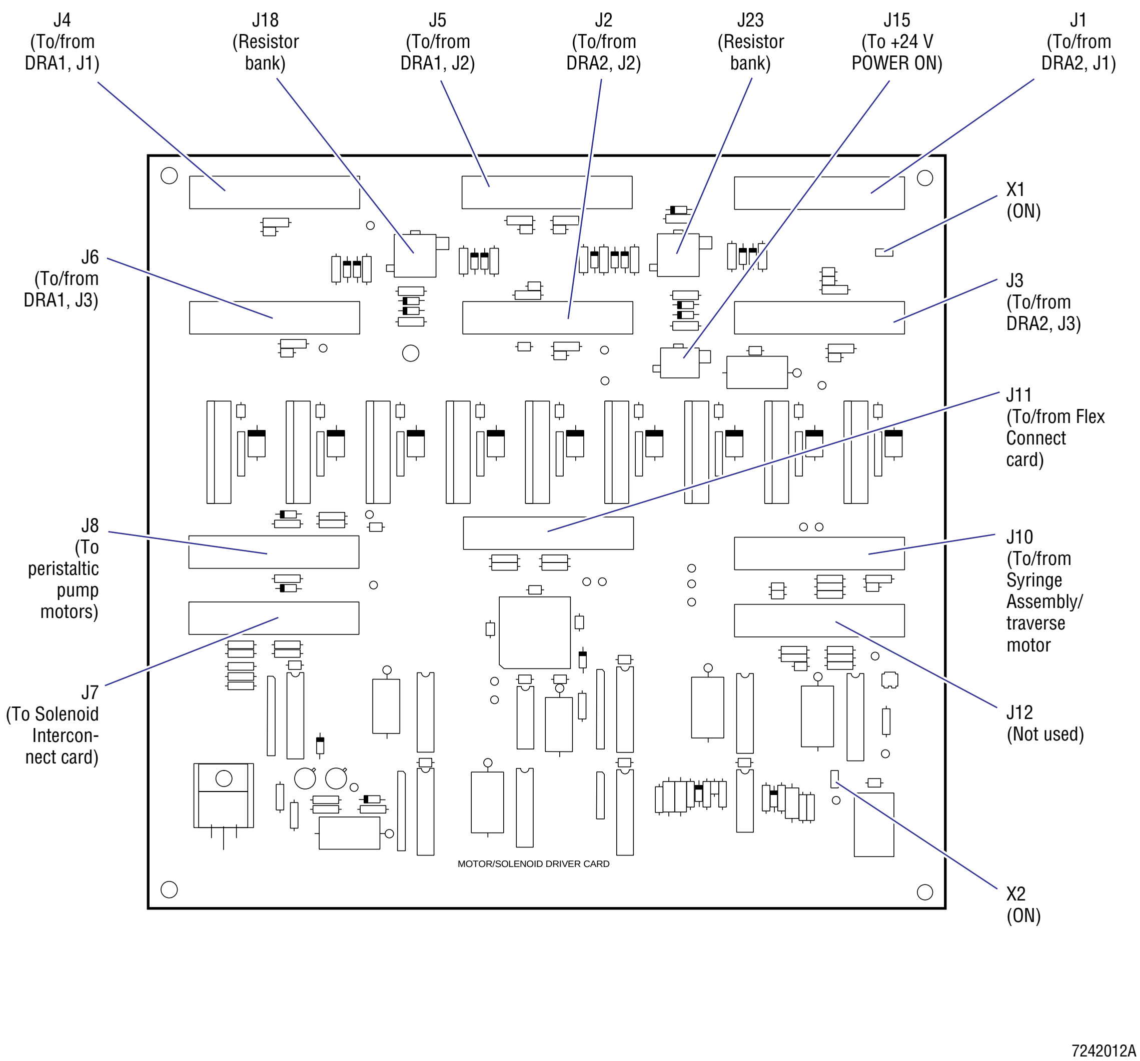
Installation

CAUTION Risk of electronic damage. Leaving jumper X1 OFF will cause damage to the card and possibly other components. The damage may not happen right away, but could happen during any instrument power ON. Before proceeding, make sure Jumper X1 is ON. See Figure 4.15-1.

1. Inspect the new card, making sure that jumpers X1 and X2 are ON (Figure 4.15-1).
2. Slide the card partially into the unit. While still easily accessible, attach connectors P7, P8, P11, and P10.
3. Slide the card all the way down and attach the remaining connectors (P6, P2, P3, P15, P18, P4, P23, P5 and P1).

4. Close the lower chassis.
5. Reconnect the ac power cable.

Figure 4.15-1 Motor/Solenoid Driver Card



Verification

1. Turn ON the instrument's power.
2. Observe the operation of the aspirate and the diluent syringes while the system is going through its power ON routine.

3. When the system reaches the Main Menu, perform the Service Diagnostic (Heading 7.3) and check for proper operation of all solenoids and the traverse motors.
4. Verify the operation of the peristaltic pumps:
   a. From the Main Menu, select **5 SPECIAL FUNCTIONS ▸▸ 3 DILUTER FUNCTIONS**.
   b. Select **4 RINSE** to check PM3.
   c. Select **3 DRAIN** to check PM4.
   d. Select **5 MIX** to check PM1.
   e. Select **4 RINSE** several times, until reservoir must refill, to check PM2.
5. Perform an SVP (Heading 5.1).

4.16 SENSOR PREAMP ADAPTER (SPA) CARD

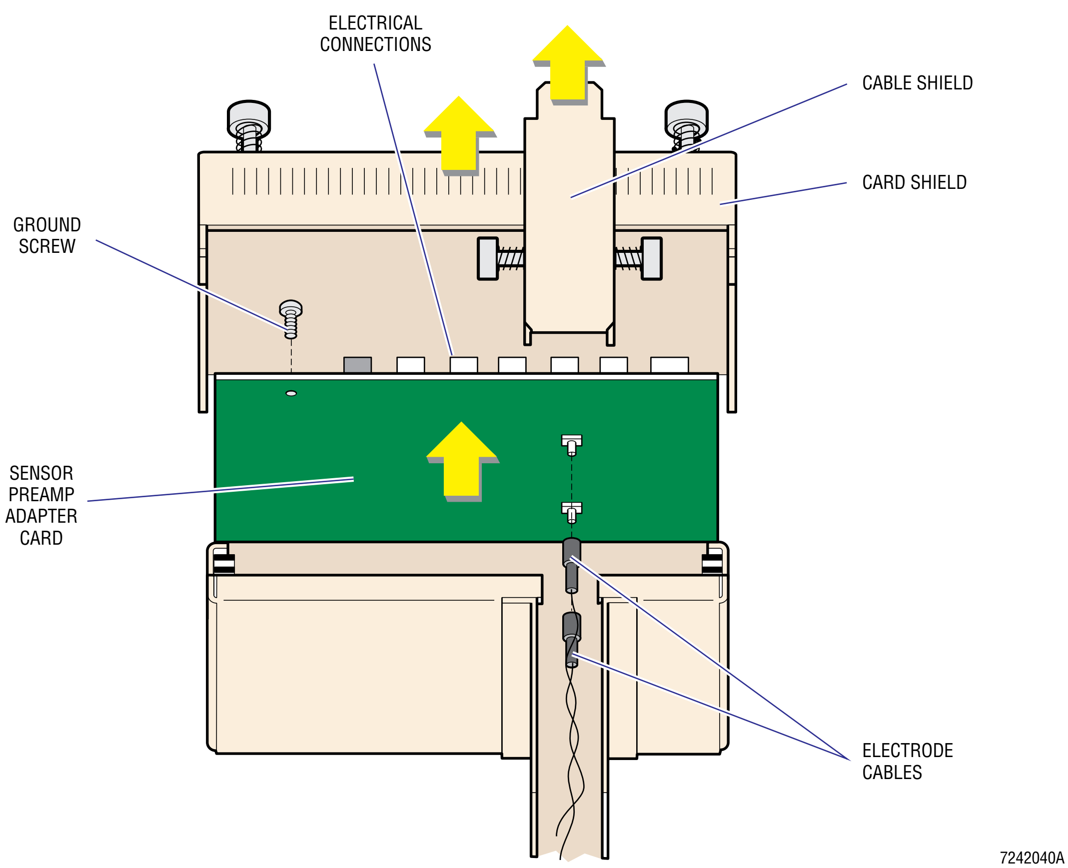
Tools/Supplies Needed

- ❑ #1 Phillips-head screwdriver

Removal

1. Turn OFF the instrument's power.
2. Open the lower chassis as directed under Heading 4.4 and locate the Sensor Preamp Adapter card (Figure 4.4-1).
3. Disconnect the electrical connectors located at the rear of the Sensor Preamp Adapter card. There are five connectors (Figure 4.16-1) and three coaxial cables.

Figure 4.16-1 Sensor Preamp Adapter (SPA) Card and Surrounding Components

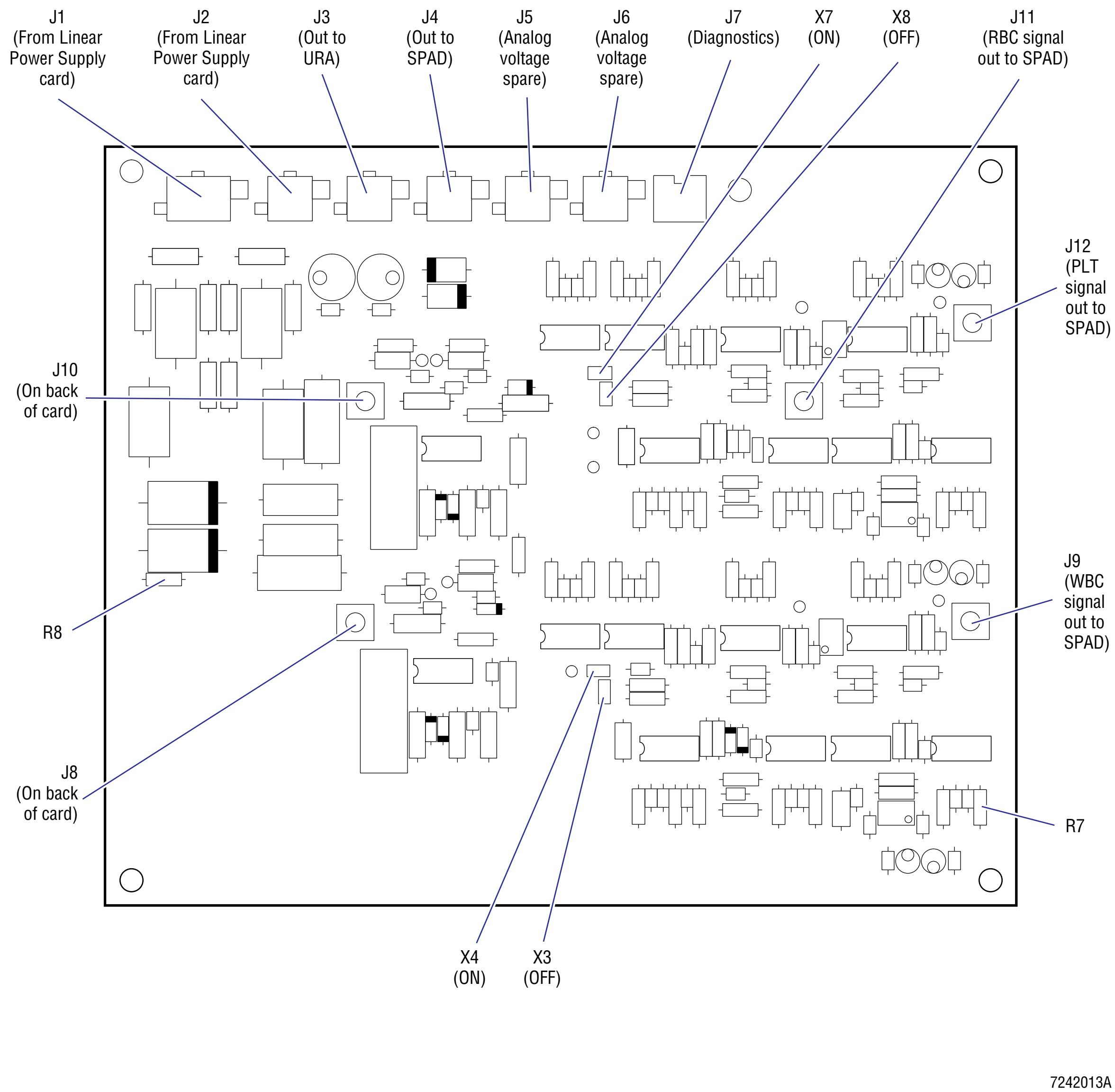


4. Remove the cable and card shield covers (Figure 4.16-1):
   - The cover for the cable shield is at the top of the "tunnel" between the Diluter Panel and the Sensor Preamp Adapter card. It is held in place with two thumbscrews, one on each side.
   - The cover for the card shield is held in place with two thumbscrews, one in each top corner. The thumbscrews are accessed from the rear of the shield.
5. Remove the ground screw for the card (Figure 4.16-1). This is a Phillips-head screw, located in the left top corner of the card and removed from the rear.
6. Remove the Sensor Preamp Adapter card by partially pulling up on the card until the bath's electrode cables (Figure 4.16-1) can be disconnected from the card. When the cables are disconnected, the card is free from the instrument.

Installation

1. Before installing the Sensor Preamp Adapter card, check the jumpers (Figure 4.16-2):
   - X4 and X7 should be ON
   - X3 and X8 should be OFF.
2. Install the replacement Sensor Preamp Adapter card into its shield. Connect the bath's electrode cables as the card is dropped into place, the WBC connector is below the RBC connector (Figure 4.16-1).
3. When the card is seated, fasten the card to the shield with the Phillips-head ground screw (Figure 4.16-1). This screw is located just left of connector J7 and is threaded from the rear.
4. Install the cable and card shield covers (Figure 4.16-1):
   - The cover for the cable shield is at the top of the "tunnel" between the Diluter Panel and the Sensor Preamp Adapter card. It is held in place with two thumbscrews, one on each side.
   - The cover for the card shield is held in place with two thumbscrews, one in each top corner. The thumbscrews are accessed from the rear of the shield.
5. Connect the five electrical connectors (Figure 4.16-1) and the three coaxial cables located at the rear of the Sensor Preamp Adapter card.
   - The five connectors - J1 through J4 and J7. J5 and J6 are not used.
   - Three output coaxial cables - J9 is the lowest, J11 is the middle, J12 is the highest.
6. Close the lower chassis.
7. Turn ON the instrument's power.

Figure 4.16-2 Sensor Preamp Adapter Card



Verification

Perform an SVP (Heading 5.1) paying particular attention to backgrounds and control recovery. If the instrument outputs histograms, verify that the control histograms appear as expected.

4.17 PROBE AND PROBE WIPE

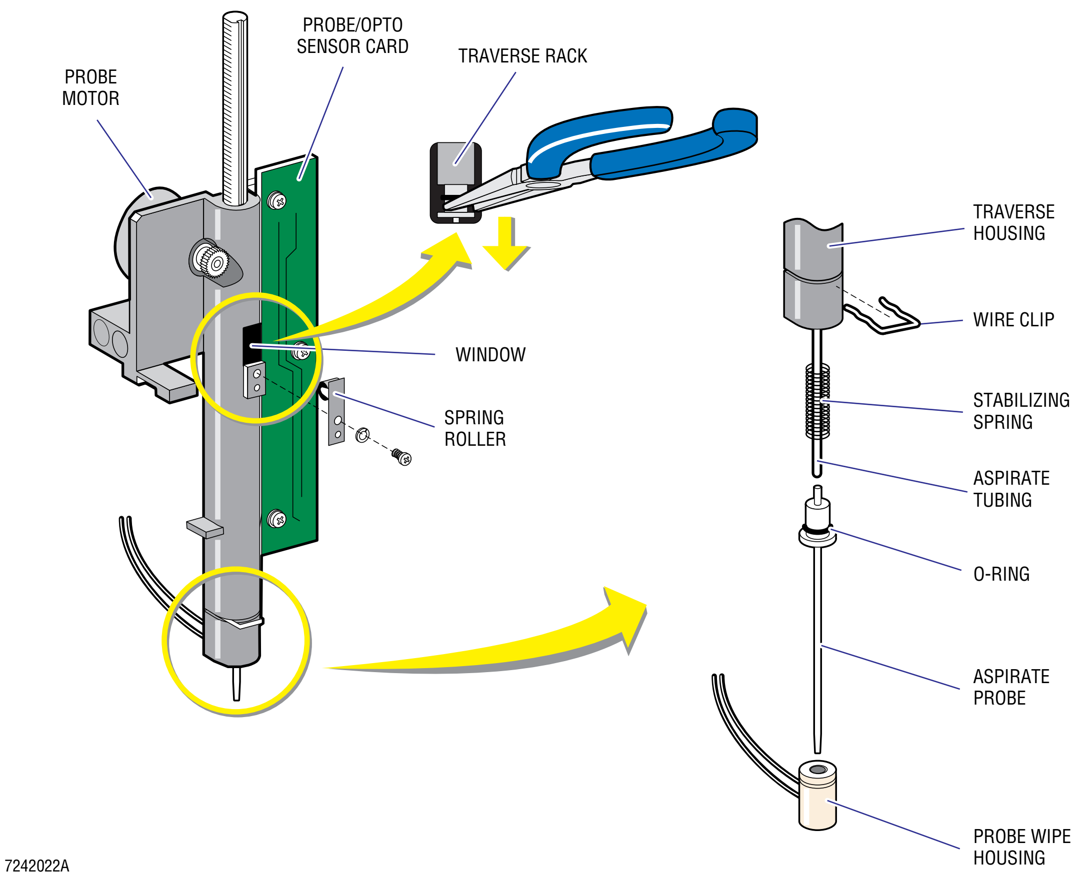
Tools/Supplies Needed

- ❑ #1 Phillips-head screwdriver
- ❑ Needle-nose pliers
- ❑ DOW CORNING 33® Lubricant, PN 1604007-0

Removal

1. Using the keypad, proceed as if you were running a sample. When the probe moves to the aspirate position, turn OFF the instrument's power.
2. Open the lower chassis, as directed under Heading 4.4, to completely expose the Probe/Wipe Traverse Assembly.
3. Remove the wire clip that retains the probe wipe housing in the traverse housing and pull down the probe wipe housing (Figure 4.17-1).

Figure 4.17-1 Probe Assembly



4. If the probe wipe housing is the part to be replaced, disconnect the tubing and then proceed to Installation, step 5.
5. Remove the spring roller near the top of the traverse housing by removing the single Phillips-head retaining screw (Figure 4.17-1).
6. Remove the aspirate probe from the traverse rack (Figure 4.17-1):
   a. Move the aspirate probe until the top of the probe is visible through the window opened by removing the spring roller in step 5 above.
   b. With needle-nose pliers or a flat-blade screwdriver, pry the aspirate probe down from the traverse rack until it is clear of the rack. The aspirate probe is held in place using a rubber O-ring to create a pressure fit.
7. Pull the aspirate probe down until the aspirate tubing has emerged from the bottom of the traverse housing (Figure 4.17-1).
8. Remove the aspirate tubing from the aspirate probe, being careful not to misplace the stabilizing spring (Figure 4.17-1).

Installation

1. Ensure that the replacement aspirate probe has an O-ring. If it does not, use a new O-ring; do not use the old one. It is a good idea to replace the O-ring any time the aspirate probe has been removed. The O-ring deteriorates after several probe removals and replacements, making it incapable of holding the probe in place.
2. Install the aspirate tubing onto the probe (Figure 4.17-1):
   a. Remember to first put the stabilizing spring over the aspirate tubing.
   b. Make sure there is no grease or contamination on the aspirate probe fitting.

IMPORTANT Risk of damage to aspirate tubing. Pre-stretching the aspirate tubing could cause tears or an improper fit that will compromise the instrument's performance. The aspirate tubing fits without being stretched. Do not pre-stretch the aspirate tubing.

   c. Push the aspirate tubing onto the aspirate probe.
3. Lightly lubricate the O-ring using a silicon grease.
4. Install the aspirate probe into the traverse rack (Figure 4.17-1):
   a. Move the traverse rack and aspirate probe until they are visible through the traverse housing window.
   b. Hold the rack and using needle-nose pliers or a flat-blade screwdriver through the window, force the aspirate probe up into the rack.

5. Install the aspirate tubing onto the probe wipe housing (Figure 4.17-1) if it was removed. The outside large bore tubing of the three-tube ribbon attaches to the top fitting while the middle tubing attaches to the bottom. The top of the probe wipe housing is the end with the groove for the wire retaining clip.
6. Thread the probe wipe housing over the aspirate probe and into the traverse housing, then install the wire retaining clip to hold it in place (Figure 4.17-1).
7. Close the lower chassis.
8. Turn ON the instrument's power.

Verification

1. Run samples and ensure that:
   - The aspirate probe moves freely and remains in place.
   - There are no fluid leaks from the probe wipe and aspirate components.
2. Perform an SVP (Heading 5.1). Control recovery verifies that you have no leaks in the aspirate tubing or its seal to the aspirate probe.

4.18 PROBE MOTOR

Tools/Supplies Needed

- ❑ #1 Phillips-head screwdriver

Removal

1. Turn OFF the instrument's power.
2. Open the lower chassis as directed in Heading 4.4, to expose the Probe/Wipe Traverse Assembly.
3. Disconnect the probe motor and the flex cable. The probe motor is connected to J2 on the Probe/Opto Sensor card (Figure 4.17-1).
4. Make sure the probe is in a vertical position. Move the traverse housing to the right end of its travel. This aligns it with two probe motor access holes in the traverse mounting bracket (Figure 4.19-1).
5. Remove the probe motor. It is fastened to the traverse housing with two Phillips-head screws.

Installation

1. Install the replacement motor, making sure that the motor gear properly meshes with the traverse rack.
2. Fasten the motor using the two Phillips-head screws. There are screwdriver access holes at the right end of the traverse mounting bracket (Figure 4.19-1).
3. Connect the motor to J2 on the Probe/Opto Sensor card and reconnect the flex cable.
4. Close the upper chassis and turn ON the instrument's power.

Verification

Perform an SVP (Heading 5.1).

4.19 TRAVERSE DRIVE BELT

Tools/Supplies Needed

- ❑ #1 Phillips-head screwdriver
- ❑ Large flat-blade screwdriver

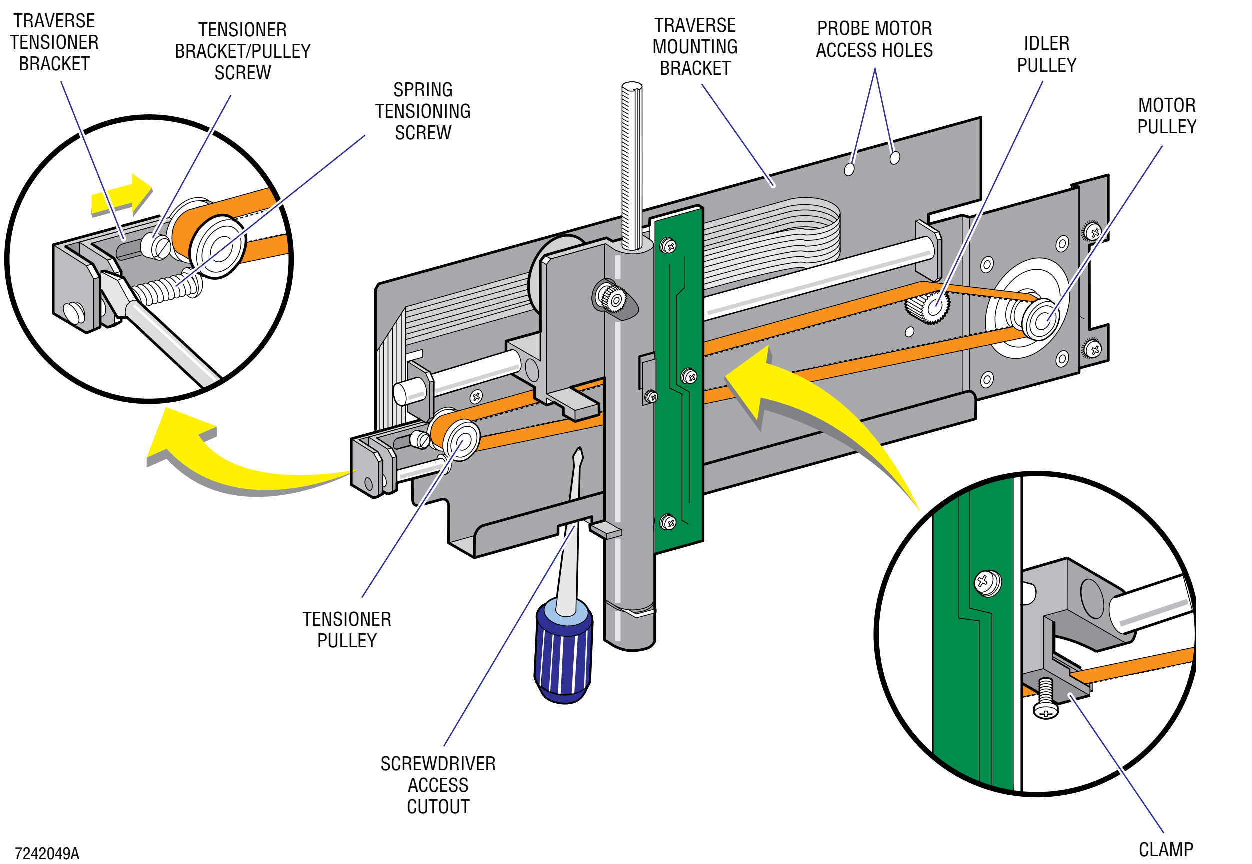
Removal

1. Turn OFF the instrument's power.
2. Open the lower chassis, as directed under Heading 4.4, to completely expose the Probe/Wipe Traverse Assembly.
3. Remove the belt from the idler pulley (Figure 4.19-1):
   a. Slide the traverse housing to the left to create more slack in the belt near the idler pulley.

      Note: There is no flange on the idler pulley. The belt slides off easily with slack.

   b. Slide the belt off the idler pulley.

Figure 4.19-1 Traverse Drive Belt



4. Remove the belt from the tensioner pulley (Figure 4.19-1):
   a. Slide the traverse housing to the right and loosen the screw that holds the tensioner bracket and pulley in place (traverse belt tensioner bracket screw).

      Note: You do not have to loosen the traverse belt spring tensioning screw. The tension is set at the factory and should not need to be altered.
   b. Remove the belt from the tensioner pulley by forcing the tensioner bracket right, against the tension spring, until there is enough slack in the belt to slide it over the pulley's flange.

      Note: A large flat-blade screwdriver can be used to pry the tensioner against the spring pressure.
5. Remove the belt from the unit (Figure 4.19-1):
   a. Locate the screwdriver access cutout in the lower left portion of the traverse mounting bracket.
   b. Loosen the #1 Phillips-head screw that clamps the belt to the traverse housing just enough to allow the belt to be removed from the clamp.
   c. Remove the belt. It is now completely free of the instrument.

Installation

1. Clamp the new belt to the traverse housing (Figure 4.19-1).
2. Install the belt onto its pulleys (Figure 4.19-1):
   - Loop the right end of the belt over the motor pulley.
   - Loop the left end of the belt over the tensioner pulley.
   - Slide the belt over the idler pulley.
3. Seat the traverse tensioner bracket and move the traverse housing back and forth to fully seat the belt (Figure 4.19-1). Once fully seated, tighten the tensioner bracket/pulley screw. The spring will have set the proper belt tension.
4. If the spring tensioning screw was moved, establish proper tension by turning the screw until the screw is just coming out of the threaded bracket. The acceptable tolerance is one to two threads exposed.

CAUTION Risk of component damage. Clamping the belt clamp too far forward or backward produces a bend during normal operation that prematurely wears the belt, traverse housing and traverse guide rod. Tighten the belt clamp on the same plane as the motor pulley to avoid premature wear on the belt, traverse housing and traverse guide rod.

5. Make sure the belt is clamped on the same plane as the motor pulley (Figure 4.19-1). If it is not, loosen the belt and reposition it.
6. Close the lower chassis and turn ON the instrument's power.

Verification

Perform an SVP (Heading 5.1). While the system is cycling, view the belt from the right-hand side to ensure there are no bends. Adjust if necessary by loosening the clamp and moving the belt.

4.20 TRAVERSE MOTOR

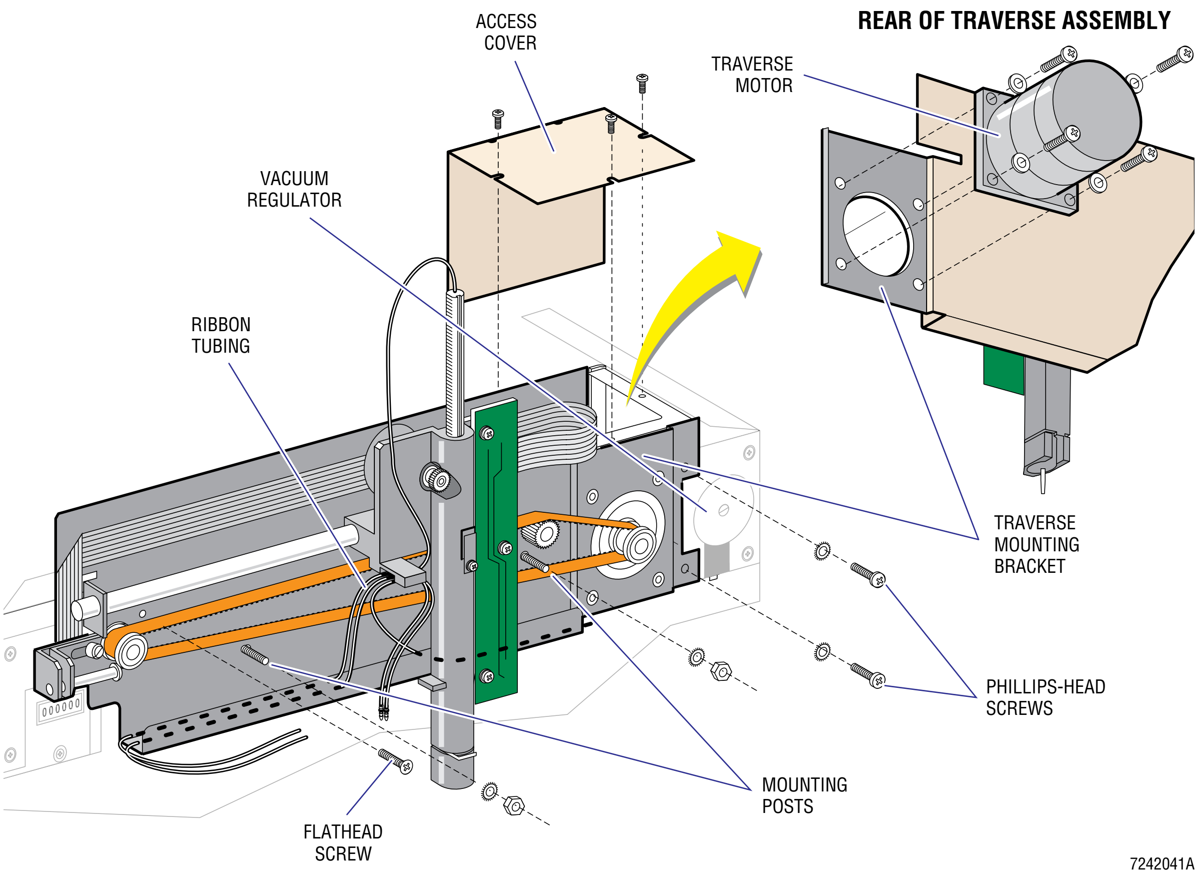
Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver
- ❑ 1/4 in. nut driver
- ❑ DOW CORNING 33 Lubricant, PN 1604007-D

Removal

1. Turn OFF the instrument's power.
2. Open the lower chassis, as directed under Heading 4.4, to completely expose the Probe/Wipe Traverse Assembly.
3. Remove the access cover at the top of the Syringe Assembly (Figure 4.20-1).

Figure 4.20-1 Traverse Motor



4. Disconnect the traverse motor. The traverse motor connector is to the right (Figure 4.20-1) and is labeled as “J5" and “TRAV MOTOR.”
5. Disconnect the following cables, making sure that these cables are free and can be removed from the instrument:
   - J15, J16 and J17 (sensor cables from the Solenoid Interconnect card)
   - J1 flex cable (from the Flex Connect card).
6. Disconnect the ribbon tubing that attaches the Traverse Assembly to the fluidics system (Figure 4.20-1):
   - The small aspirate tubing connects to the aspirate syringe manifold.
   - The middle tubing connects to port #2 of LV8.
   - The large bore, outside tubing connects to the normally open port of LV16.
7. Remove the five fasteners attaching the Traverse Assembly to the lower chassis. There are three Phillips-head screws, two on the extreme right edge of the traverse mounting bracket and one Phillips-flathead screw just above the right corner of the tensioner bracket. The last two fasteners are 1/4 in. nuts located about 4 in. from each end of the traverse mounting bracket.
8. With the Traverse Assembly on the bench, remove the traverse motor from the traverse mounting bracket by removing the four retaining screws (Figure 4.20-1).

Installation

Before installing the replacement motor, make sure that it has a wear plate and a rubber seal. The wear plate is attached to the motor with black RTV compound and the rubber seal is installed concave end toward the wear plate and lubricated with DOW CORNING 33 Lubricant.

1. Attach the traverse motor to the traverse mounting bracket with the four retaining screws (Figure 4.20-1).
2. Hang the Traverse Assembly onto the two mounting posts, threading the connector cables through the lower chassis at the same time.
3. Attach and tighten the three Phillips-head screws (Figure 4.20-1).
4. Attach and tighten the two 1/4-in. nuts onto the mounting posts (Figure 4.20-1).
5. Connect the ribbon tubing to the fluidics system (Figure 4.20-1):
   - The small aspirate tubing attaches to the long special fitting at the front of the aspirate syringe manifold.
   - The middle tubing attaches to the #2 port of LV8.
   - The larger bore outside tubing attaches to the normally open port of LV16.

6. Connect the electrical connectors:
   - Flex cable (from Probe/Opto Sensor card) to J1 (on Flex Connect card).
   - Traverse motor to J5 (behind the Syringe Assembly).
   - Aspirate position sensor to J17 (on Solenoid Interconnect card).
   - WBC position sensor to J15 (on Solenoid Interconnect card).
   - RBC position sensor to J16 (on Solenoid Interconnect card).
7. Replace the access cover, lower the upper chassis and turn ON the instrument's power.

Verification

Perform an SVP (Heading 5.1).

4.21 SYRINGE ASSEMBLY

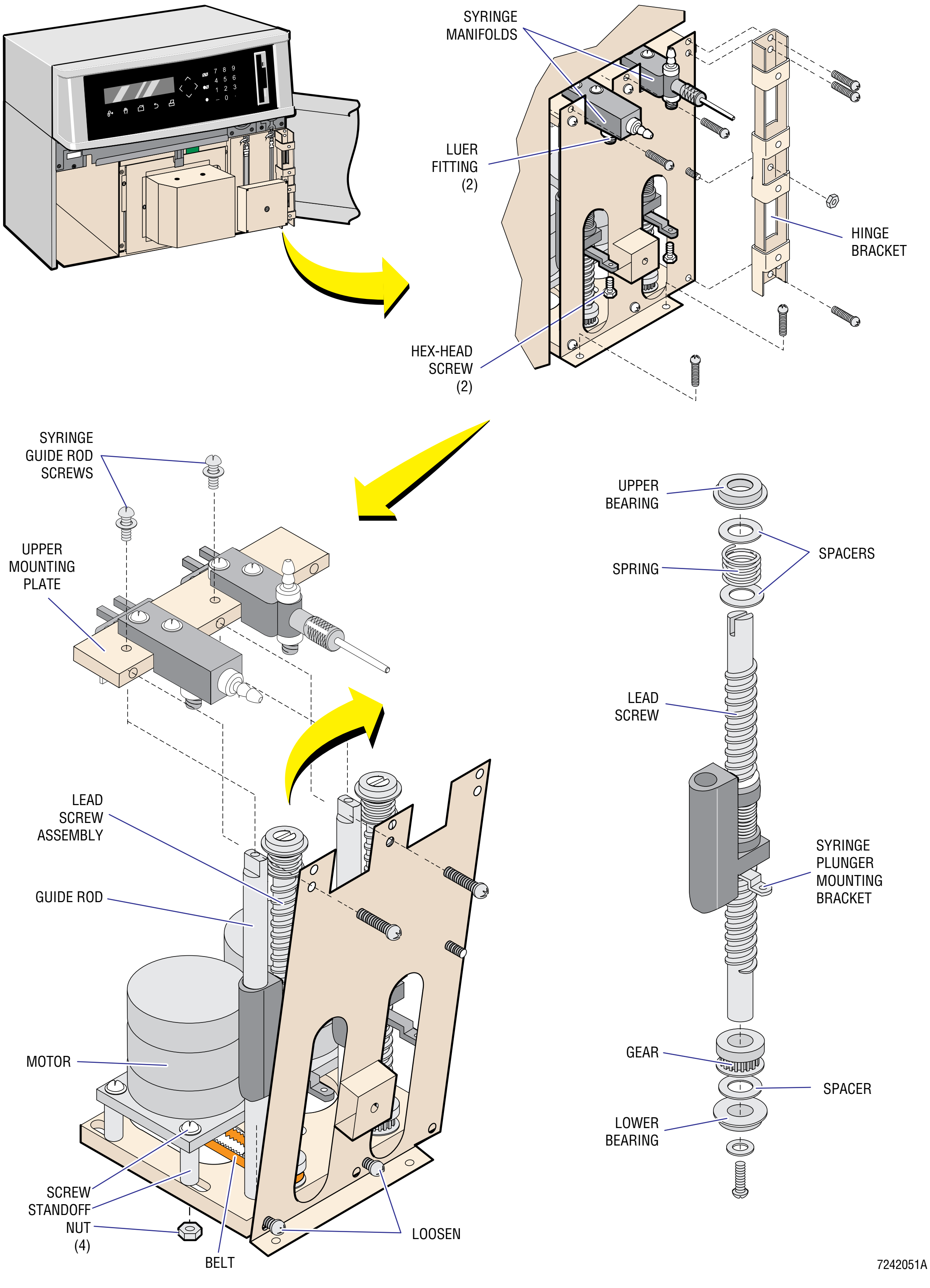
Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver
- ❑ 1/4 in. HEX-nut driver
- ❑ 1/16 in. HEX-key wrench
- ❑ Large flat-blade screwdriver
- ❑ LOCTITE® 242 THREADLOCKE2 adhesive, PN 1601018-9

Removal

1. From the Main Menu, select **5 SPECIAL FUNCTIONS ▸▸ 5 SERVICE ▸▸ 2 REPLACE SYRINGE**.
2. Turn OFF the instrument's power.
3. Open the lower chassis, as directed under Heading 4.4, to completely expose the Probe/Wipe Traverse Assembly.
4. Remove the Phillips-head screw (in the center) that secures the metal shield. Remove the metal shield that covers the lower portion of the syringes.
5. Remove the 1/4-in. HEX-head screws at the bottom of each plunger (Figure 4.21-1).
6. Unscrew the syringe bodies from the Luer fittings (Figure 4.21-1).
7. Remove the door from the Syringe Assembly by removing the hinge bracket (Figure 4.21-1) from the Syringe Assembly. It is fastened to the instrument with three Phillips-head screws and one nut.
8. Remove the Syringe Assembly from the unit. Four Phillips-head screws remain that fasten the Syringe Assembly to the lower chassis (Figure 4.21-1).
   - Two vertically-oriented screws are threaded to the floor of the lower chassis.
   - Two screws remain along the top of the assembly, one left and one center.
9. Attach a hemostat to the diluent tube.
10. Slide the assembly out of the lower chassis:
    a. When it is far enough out, remove the three tubes connected to the syringe manifolds.
    b. Slide the assembly out further until the cables can be disconnected. There are four cables and they connect to the rear wall of the syringe cavity.
11. Loosen the screws fastening the motor associated with the syringe components that you are replacing. If the motor is to be replaced, remove the screws, being careful not to lose standoffs and nuts.

Figure 4.21-1 Syringe Assembly



12. Free the syringe lead screw assemblies (Figure 4.21-1):
    a. Remove the two screws fastening the upper mounting plate to the top of the front plate.
    b. Remove the two screws fastening the syringe guide rods to the upper mounting plate.
    c. Remove the upper mounting plate with manifolds and sensors still attached.

ATTENTION: There are two spacers and one spring for each syringe. Do not lose them, they are critical to syringe operation.

13. Remove the hardware at the top of each syringe and set aside.
14. Remove the belt from the motor gear first, then the lead screw gear. There will be enough play in the motor assembly and lead screw assembly to work it off.
15. If the lead screw assembly is to be replaced, loosen the two screws that fasten the front plate to the lower mounting plate (Figure 4.21-1). This will allow the lead screw assembly to be pulled up and away from the Syringe Assembly.
16. Remove the lower bearing, spacer and gear from the bottom of the lead screw (Figure 4.21-1).
17. Remove the syringe plunger mounting bracket from the lead screw assembly.

Installation

1. Install the syringe plunger mounting bracket, lead screw gear, spacer and lower bearing onto the replacement lead screw assembly (Figure 4.21-1):

   ATTENTION: The thickness of the spacer is very important. If it is lost, replace it with the proper part.

   - Push the gear onto the lead screw as far as it will go.
   - Before tightening the setscrews, tighten one against the flat part of the lead screw shaft.
   - Before tightening the screws, use LOCTITE 242 THREADLOCKE2 on the Phillips-head screw that fastens the bearing to the lead screw.
2. If the motor had been removed, install the motor at this time. Do not tighten the motor in place yet, it is used to adjust belt tension.
3. Install the replacement lead screw assembly into the Syringe Assembly. Do not fasten yet.
4. Install the drive belt by putting the belt around the lead screw gear first, then around the motor gear.

5. Install the upper mounting plate (Figure 4.21-1):
   a. Replace the upper lead screw hardware, with a spacer going on first, then the spring, then another spacer.
   b. Place the upper mounting plate onto the two syringe lead screws and fasten to the two guide rods. Tighten each screw a bit at a time until both are tight.
   c. Check that the drive belt is still around both gear assemblies. If it is, fasten the upper mounting plate to the face plate.
   d. Tighten all six face plate screws at this time.
6. Tighten the motor assembly to the proper belt tension. Belt tension is set to 4 lb at the factory. An acceptable alternative is to tighten the belt such that easy finger pressure to the belt will push it half way, or about 1/4 in. toward the belt on the other side of the loop.
7. Verify that the belt gears are at the same level so that the belt is not at an angle. If an adjustment is required, change the position of the motor gear.
8. Install the Syringe Assembly into the instrument:
   a. Connect the four electrical connectors, P1 through P4.
   b. Connect the three fluid lines.
   c. Fasten the assembly to the instrument. Four Phillips-head screws fasten the Syringe Assembly to the lower chassis (Figure 4.21-1).
      - Two vertically-oriented screws are threaded to the floor of the lower chassis.
      - Two screws remain along the top of the assembly, one left and one center.
9. Fasten the hinge bracket (Figure 4.21-1) and the door to the Syringe Assembly using three Phillips-head screws and one nut.

Verification

1. Turn ON the instrument's power.
2. Observe the Syringe Assembly during power up.
3. If no problems are observed, run a prime cycle to prime the system with diluent. Observe the syringe area for smooth movement of the syringes and for fluid leaks.
4. If no problems are observed, replace the metal shield that covers the lower syringe area.
5. Perform an SVP (Heading 5.1).

4.22 PERISTALTIC PUMP MOTOR AND SPOOL

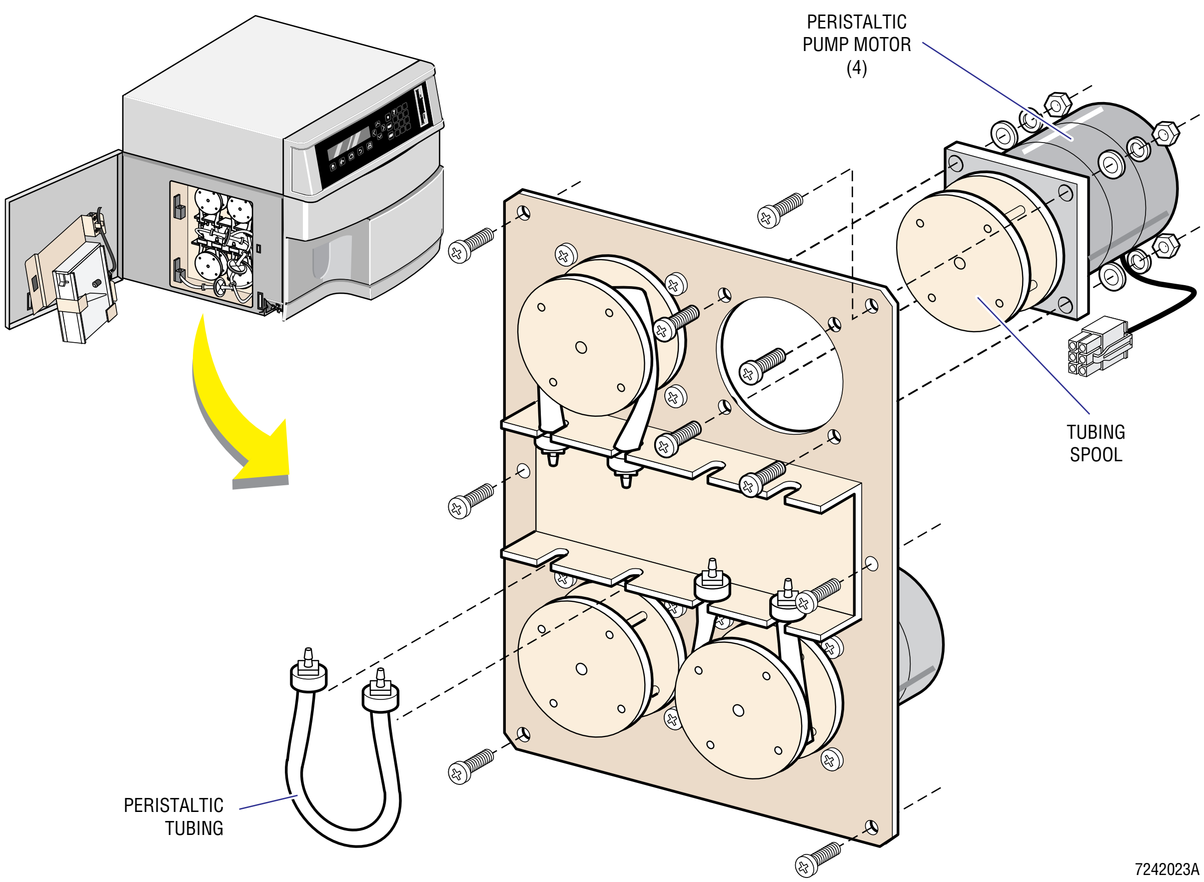
Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver
- ❑ 1/16 in. HEX-key wrench
- ❑ DOW CORNING 33 Lubricant, PN 1604007-0

Removal

1. Turn OFF the instrument's power.
2. Access the Peristaltic Pump Assembly:
   a. Open the small door on the left side of the unit that holds the diluent reservoir (Figure 4.22-1).

Figure 4.22-1 Peristaltic Pump Motors



   b. Disconnect the diluent sensor connector and lift the door off its hinges.
   c. Prop the door out of the way toward the rear of the instrument, keeping in mind that the diluent tank will spill any fluid it contains, if laid on its side.

3. Remove the Peristaltic Pump Assembly from the lower chassis. It is held in place with six Phillips-head screws (Figure 4.22-1). There should be enough play in the tubing and wiring to allow work on the assembly without disconnecting it.
4. Remove the peristaltic tubing from the pump (Figure 4.22-1).
5. Remove the tubing spool from the motor shaft (Figure 4.22-1). This spool is fastened with two HEX-head setscrews that tighten against the shaft. If you are replacing the motor, this step could be performed after you remove the motor, since the opening in the mounting plate will allow the spool through. If you are replacing the spool, go to Installation, step 3, below.
6. Disconnect the electrical connector at the back of the motor you wish to replace.
7. Disconnect the four Phillips-head screws with nuts (Figure 4.22-1) and remove the motor.

Installation

1. Make sure the replacement motor has a wear plate and a rubber seal. The wear plate is attached to the motor with black RTV compound and the rubber seal is installed concave end toward the wear plate and lubricated with DOW CORNING 33 Lubricant.
2. Attach the motor using the four Phillips-head screws and nuts (Figure 4.22-1).
3. Attach the tubing spool if it has not already been attached (Figure 4.22-1). The tubing spool is fastened to the motor shaft using two HEX-head setscrews that must line up with the flattened portion of the motor shaft. The spool is pushed onto the shaft as far as it will go.
4. Attach the Peristaltic Pump Assembly to the lower chassis using six Phillips-head screws (Figure 4.22-1).
5. Reconnect any motors that were disconnected.
6. Install the diluent reservoir door onto the lower chassis (Figure 4.22-1).
7. Connect the diluent level sensor and wind the peristaltic tubing onto the pump spool.
8. Turn ON the instrument's power.

Verification

1. Verify the operation of the peristaltic pumps:
   a. From the Main Menu, select **5 SPECIAL FUNCTIONS ▸▸ 3 DILUTER FUNCTIONS**.
   b. Select **4 RINSE** to check PM3.
   c. Select **3 DRAIN** to check PM4.
   d. Select **5 MIX** to check PM1.
   e. Select **4 RINSE** several times, until reservoir must refill, to check PM2.
2. Perform an SVP (Heading 5.1).

4.23 VACUUM PUMP

Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver

Removal

1. Turn OFF the instrument's power.
2. Disconnect the ac power cable.
3. Open the lower chassis, as directed under Heading 4.4, and locate the vacuum pump (Figure 4.4-1).
4. Disconnect the electrical connector for the vacuum pump.
5. Disconnect the single tubing connected to the left end of the pump.
6. Remove the vacuum pump from the instrument. It is attached to the lower chassis floor with four Phillips-head screws.

Installation

1. Check that there is a right-angle fitting on the vent port. This port is located on top of the pump.
2. Connect the diluter tubing to the end port of the vacuum pump, and the electrical input cable to the power supply cable that comes from J7 on the AC Power/Vacuum Relay card.
3. Fasten the pump to the floor of the lower chassis using four Phillips-head screws. Make sure the output port of the pump faces left.
4. Close the lower chassis, reconnect the ac power cable and turn ON the instrument's power.

Verification

1. Perform a Vacuum Adjustment (Heading 4.30).
2. Run several sample cycles without aspirating anything.
3. Check for any fluid leaks from the probe wipe. Raw pump vacuum is used to evacuate fluids from the probe wipe housing and you must verify that there is sufficient vacuum to accomplish this.
4. Perform an SVP (Heading 5.1).

4.24 APERTURE, BATH AND APERTURE ELECTRODE MODULE

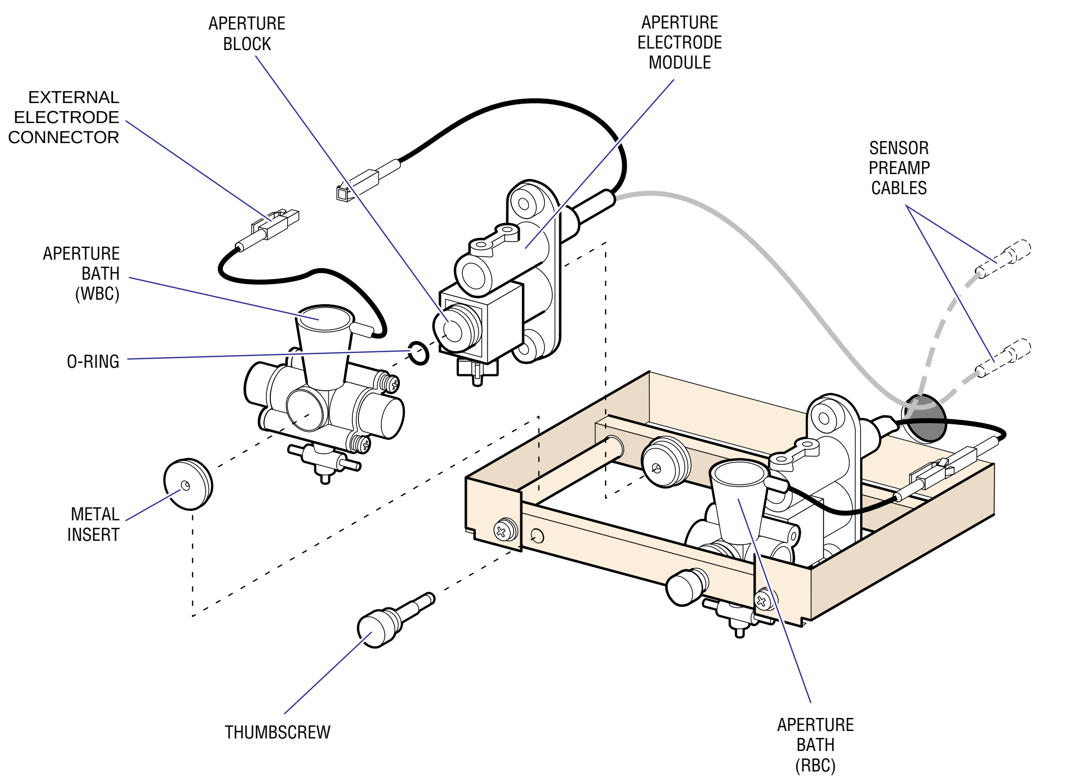
Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver

Removal

1. Drain the baths.
2. Turn OFF the instrument's power.
3. Open the lower chassis as directed in Heading 4.4.
4. Gain access to the aperture area by removing the Diluter Panel shield with door. The shield is held in place with three captive thumbscrews.
5. Remove the three tubes connected to the bottom of each bath.
6. Disconnect the external electrode connector (Figure 4.24-1). This is a single pin MATE-N-LOK® connector coming from the top of each bath and going to the shield wire of the Aperture Electrode module coaxial cable

Figure 4.24-1 Aperture Bath Assembly



7. Remove the thumbscrew at the front of the aperture bath assembly (Figure 4.24-1). The bath, aperture, and rear module are pressure-fit and this thumbscrew provides the pressure.
8. Remove the aperture bath. To get enough room at the front of the bath to clear the aperture block, you may have to remove the metal insert (Figure 4.24-1) that the thumbscrew presses against.
9. If you are replacing the bath only, go to Installation, step 2.
10. If you are replacing the RBC aperture block, remove the sweep-flow tubing. Loosen the fitting that pushes up against the aperture from underneath. This allows the aperture block to be easily pulled out of the Aperture Electrode module.
11. Remove the aperture blocks from the Aperture Electrode module (Figure 4.24-1). The Aperture Electrode module is not attached and can be moved to a convenient working position.
12. If you are not going to replace the Aperture Electrode module, go to Installation, step 3 of this section.
13. Open up the lower chassis and raise the upper chassis.
14. Remove the two covers that shield the Sensor Preamp Adapter card and the electrode cables. See the replacement procedures (Heading 4.16) for details on removing these covers.
15. Slide the Sensor Preamp Adapter card up until you can remove the electrode cable for the Aperture Electrode module you are replacing.
16. Remove the Aperture Electrode module by pulling the cable through the Diluter Panel (Figure 4.24-1).

Installation

1. Install the new Aperture Electrode module into the unit:
   a. Feed the coaxial cable through the hole in the Diluter Panel (Figure 4.24-1).
   b. Slide the Sensor Preamp Adapter card up until you can connect the coaxial cable to its proper connector. The lower connector is for the WBC module and the upper connector is for the RBC module.
   c. Replace the shield covers for the Sensor Preamp Adapter card and the electrode cables.
   d. Close the upper chassis.

2. Install the aperture block (Figure 4.24-1):
   a. Verify that there are small O-rings at the top and bottom of the block.
   b. Verify that the O-rings are in good condition. If they are too flat or beginning to deteriorate, replace them.
   c. Verify that the area around the aperture bath is dry.
   d. Tighten the fitting below the aperture block. It only needs to be snug, or tight enough to ensure that the O-ring seals are compressed.
3. Install the aperture bath (Figure 4.24-1):
   a. Verify that the large aperture O-ring seal is seated in its groove in the bath. This seal will be pressure-fit against the front of the aperture block.
   b. Position the Aperture Electrode module against the rear pressure plate.
   c. Slide the bath in place until it can be fit onto the aperture block.
   d. Set the metal insert (front pressure plate) in place and tighten the thumbscrew against it. This should be a snug fit, only finger-tight.
4. Connect the bath electrode (external electrode connector) to the connector on the Aperture Electrode module (Figure 4.24-1).

Verification

1. Turn ON the instrument's power.
2. Perform a startup. Observe the bath and aperture area closely for any fluid leaks or air leaks in the sweep flow or internal electrode path.
3. Replace the inner shield door and close the lower chassis.
4. If there are no visible problems, perform an SVP (Heading 5.1).

4.25 DILUTER PANEL SOLENOIDS

Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver

Removal

1. Turn OFF the instrument's power.
2. Open the lower chassis as directed in Heading 4.4.
3. Locate the Solenoid Interconnect card (Figure 4.4-1).
4. Disconnect the connector for the solenoid you are replacing and free the cable of any wire ties or obstructions so that the connector can easily be pulled through the Diluter Panel from the front.
5. If there is an extension cable on the solenoid (LV5, LV11), remove it and install it on the replacement solenoid.
6. Remove the Diluter Panel shield with door. The shield is held in place with three captive thumbscrews.
7. Remove the two screws that hold the solenoid onto the Diluter Panel. The screws are visible from the front and there is no loose hardware to contain when removing the screws.
8. Pull the solenoid out of the Diluter Panel being careful not to snag the connector.

Installation

1. Push the wiring and connector for the new solenoid through the Diluter Panel mounting, hole and with two screws fasten the solenoid to the Diluter Panel.
2. Locate the connector (using a hemostat if necessary) and connect the cable to the Solenoid Interconnect card.
3. Replace the Diluter Panel shield with door, with three captive thumbscrews.
4. Turn On the instrument's power.

Verification

1. Run the Service Diagnostic in Table 7.3-1, to verify solenoid operation. Putting a finger on the small plunger at the front of the solenoid helps verify mechanical activation.
2. Perform an SVP (Heading 5.1).

4.26 SWEEP-FLOW TUBING

Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver
- ❑ Needle-nose pliers
- ❑ Small-side cutter

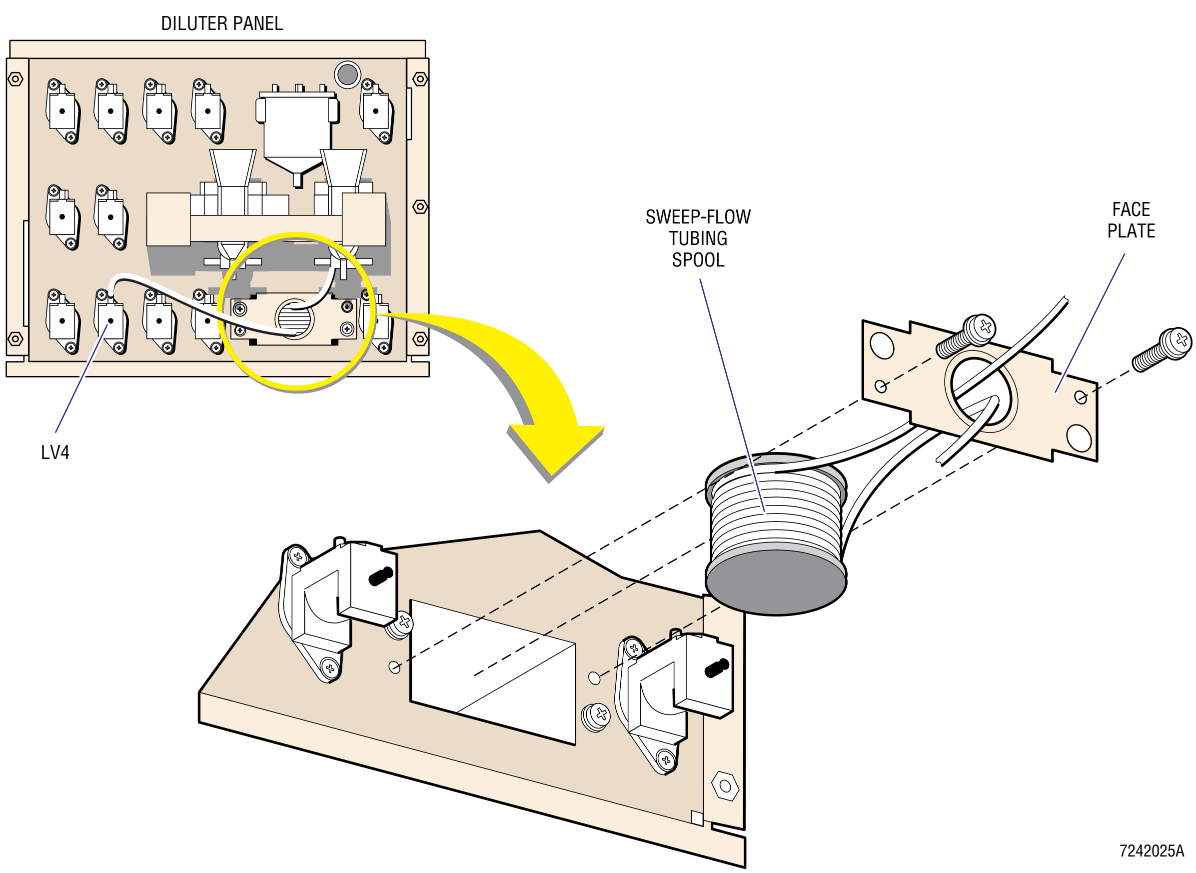
Removal

1. Open the lower chassis as directed in Heading 4.4.
2. Gain access to the aperture area by removing the Diluter Panel shield with door. The shield is held in place with three captive thumbscrews.
3. Disconnect the sweep-flow tubing. One end is attached to port 1 of LV4 and the other is attached to the RBC aperture sweep-flow fitting on the Diluter Panel (Figure 4.26-1).

ATTENTION: Do not remove the upper left and lower right screws. This will release the box shield attached to the back of the Diluter Panel.

4. Remove the face plate covering the sweep-flow tubing spool that is held in place by two Phillips-head screws, one lower left and one upper right (Figure 4.26-1).
5. Remove the sweep-flow spool with tubing (Figure 4.26-1). It is not attached.

Figure 4.26-1 Sweep-Flow Tubing



Installation

1. Wind 13 ft (evenly back and forth) of PN 3202220-1 tubing onto the spool, being careful to leave 4 in. at one end and 5 in. at the other end. The tubing must all fit in the spool when wound.
2. Thread the exposed ends of the tubing through the face plate and place the spool in its cavity (Figure 4.26-1).
3. Fasten the face plate to the Diluter Panel (Figure 4.26-1).
4. Connect the 4 in. tubing lead to the RBC aperture sweep-flow fitting and the 5 in. lead to port 1 of LV4 (Figure 4.26-1).
5. Close the lower chassis.

Verification

1. Prime the sweep flow.

   Note: Instrument cycles may not be sufficient in some cases. When that happens, use the syringe to prime the sweep flow.
2. Perform an SVP (Heading 5.1), paying close attention to Plt results and histograms. If there is a sweep-flow problem, you will see a large spike at the beginning of the histogram.

4.27 LATEX GAIN ADJUSTMENT

Tools/Supplies Needed

- ❑ Latex aperture gain particles, PN 6857371-8

Procedure

1. Ensure that the instrument is primed and ready to run a sample.
2. At the Main Menu, select **5 SPECIAL FUNCTIONS ▸▸ 5 SERVICE ▸▸ 1 LATEX GAIN**.
3. Enter the latex particle size from the assay value stated on the container.
4. Make sure the latex aperture gain particles are well mixed, then aspirate them as directed on the display.
5. Compare the WBC and RBC results to the latex assay value. A display of Counts, CVs and Sizes is given for WBC and RBC.
   - Verify that the RBC CV is ≤8 and the WBC CV is ≤16. Results not meeting this criteria should not be used for adjustments.
   - Adjustment is necessary if either parameter is not within 1.5 fL of the latex assay value. Press **Enter** to advance to the Adjustment menu.
6. The Adjustment menu displays the new aperture current setting.
   - Do not adjust the WBC if is it is outside the range of 99.6 to 140.4 V. Do not adjust the RBC if is it is outside the range of 124.5 to 175.5 V.
   - If you cannot adjust within range, there is a problem that requires correction.
   - To leave the Adjustment menu without making an adjustment, press **Escape**.
7. Run controls to verify calibration. Changes in aperture gain affect MCV and MPV the most. Histogram shifts also occur.

4.28 AIM ADJUSTMENT

Tools/Supplies Needed

- ❑ Five different whole-blood specimens with normal parameters (especially for WBC)

  Note: Since nomal parameters do not guarantee a normal AIM result, it is preferable to use different blood.

Procedure

1. Bleach the apertures. Refer to the How to Clean the Baths procedure in the Operator's Guide.
2. Run each of the five specimens once. After each sample, access the Service Report (see Heading 7.2, GENERATING A SERVICE REPORT), and print or record the measured 26th-percentile AIM reading for RBC and WBC.
3. Average the five, measured, 26th-percentile readings for RBC and WBC. These results are your new "target values."
4. Verify that the RBC Target (T) value falls within the 2150 to 2550 range and that the WBC Target (T) value falls withing the 2100 to 2500 range. If either are outside of these ranges, there is an instrument problem that must be resolved before continuing.
5. **If the new target values are within** ±25 of the current (old) target values, do not adjust. If adjustment is necessary, access the Service Report screen (see Heading 7.2, GENERATING A SERVICE REPORT), and enter the new target values.

Optional Procedures

Option 1

Controls and calibrators have different physical properties from fresh whole blood. The 26th percentile readings that they produce can also differ, and generate AIM alerts if the differences are great enough. If the WBC 26th percentile is too low, as is the case with COULTER 4C® PLUS Abnormal Low cell control, target adjustments up to 2% are allowed. There is no allowance for the WBC 96th percentile reading being too high, or for the RBC 26th percentile reading being too high or too low.

1. Obtain a WBC 26th percentile average for fresh whole blood, following the procedure above.
2. Run the control (Abnormal Low if 4C cell control is being used) five times and average the WBC 26th percentile readings.
3. Average the fresh blood average and the control average. This is the same as averaging all 10 runs. Compare this result to the fresh blood average less 2% (fresh blood average x 0.980). Adjust to the higher value.
4. If 4C Abnormal Low cell control was used, it is acceptable to adjust to 1.02 x the 4C Abnormal Low cell control average.

Option 2

Many customers in the MD II market do not have samples of blood at installation, or have only fingerpick samples, which are not ideal for AIM adjustment. Though not preferred, 4C PLUS cell control can be used to adjust the AIM values.

This method produces an RBC 26th percentile target similar to the preferred fresh whole-blood results. For WBC, the value is about 1.5% lower than the value produced using fresh whole blood. Since the low control is generally about 3.0% below the AIM target for fresh blood, using this lower 26th percentile value is an acceptable compromise. If a value matching fresh whole blood is desired, multiply the average WBC obtained value by 1.015.

1. Run the high control five times. Print or record the WBC and RBC measured 26 percentile value after each run.
2. Average the five WBC and the five RBC 26th percentile readings.
3. If the averages are within ±25 of the instrument target values, do not adjust. If the averages are outside this range, adjustment is required. Adjust to the average values.

4.29 HGB PREAMP ADJUSTMENT

Tools/Supplies Needed

- ❑ #2 Phillips-head screwdriver
- ❑ DVM with a 3 1/2 digit display
- ❑ Pot adjustment tool or small-blade screwdriver

Procedure

1. Ensure the system is primed and that there is clear diluent in the WBC bath.
2. Open the lower chassis, as directed under Heading 4.4, and locate the Hgb Preamp card (Figure 4.4-1).
3. Adjust the Hgb-blank reading. Using TP2 or the chassis ground for the negative lead and TP1 for the positive lead, adjust R7 for a DVM reading of 4.5 V.

ATTENTION: When covering the photodetector, make sure no light can get to the detector. Remove it from the WBC bath if necessary.

4. Adjust the Hgb Zero Offset. Cover the photodetector so that it receives no light and adjust R8 until a reading of 0.0 ±1 mV is attained.
5. Restore the Hgb system and check the original Hgb-blank reading. If it has changed by more than 0.05 V, repeat the blank and zero adjustments.
6. Restore the instrument to operating status and perform an SVP (Heading 5.1).

   Note: Though a DVM is preferable, this adjustment can be performed using the service voltage display.

4.30 VACUUM ADJUSTMENT

Procedure

1. At the Main Menu, select **5 SPECIAL FUNCTIONS ▸▸ 5 SERVICE ▸▸ 5 VACUUM ADJUST**.
2. Using the vacuum regulator (Figure 4.20-1) in the upper-right corner of the fluidics panel, adjust as close to 6.00 in. Hg as possible. The system tolerance limit for vacuum is 5.83 to 6.17 in. Hg.

4.31 LYSE VOLUME ADJUSTMENT/VERIFICATION

Note: This procedure need not be performed frequently. The solenoid pump is very accurate and stable. Once adjusted correctly, it should not require readjustment. Any drift or variability in the volume is most likely caused by a problem elsewhere in the lyse system.

Tools/Supplies Needed

- ❑ Lyse volume-adjustment measuring vial, PN 5415483-6, or a 5-mL graduated measuring device
- ❑ 9/16 in. or adjustable wrench
- ❑ Large (1/4 in.) flat-blade screwdriver

Procedure

1. At the Main Menu, select **5 SPECIAL FUNCTIONS ▸▸ 3 DILUTER FUNCTIONS ▸▸ 3 DRAIN**.
2. Disconnect the lyse pump output tubing from the Y-fitting below the WBC bath.
3. Insert the open end of the output tubing into a waste container.
4. At the Diluter Functions menu, select **2 DISPENSE LYSE**. Dispense lyse once if the system is primed, or as many times as necessary to prime the system if it is unprimed.
5. When there are no bubbles in the lyse system, insert the output tubing into an empty measuring vial and dispense lyse 10 times.
6. Check the meniscus of the lyse:
   - If the meniscus does not fall within the two indicating lines on the vial (the lines represent 4100 and 4200 µL), adjust the lyse pump. Go to step 7.
   - If the meniscus is within the two indicating lines on the vial, go to step 11.
7. To adjust the pump:
   a. Loosen the adjustment screw locknut at the bottom of the lyse pump.
   b. Turn the adjustment screw clockwise to decrease volume or counterclockwise to increase volume.

   Note: The adjustment is very coarse, approximately 80 µL for each turn of the screw.
8. When satisfied with the adjustment, tighten the locknut, trying not to turn the adjustment screw.
9. Rinse and dry the vial.
10. Dispense lyse once into the waste container, then dispense 10 times into the empty measuring vial to verify correct volume. Repeat the adjustment if the volume is incorrect.
11. Reconnect the lyse tubing, dispense lyse twice, then select **4 RINSE**.
12. Perform an SVP (Heading 5.1).

5 **MAINTENANCE PROCEDURES, 5.1-1**

5.1 SYSTEM VERIFICATION PROCEDURE (SVP), 5.1-1

5.2 PMI RECOMMENDATIONS, 5.2-1
- Components, 5.2-1
  - Filters, 5.2-1
  - Peristaltic Pump Tubing, 5.2-1
  - Polyurethane Tubing, 5.2-1
  - Syringes, 5.2-1
- Cleaning, 5.2-1
- Adjustment Procedures, 5.2-2
- Verification Procedures, 5.2-2

5.1 SYSTEM VERIFICATION PROCEDURE (SVP)

1. Inspect the blue and green filters and change if required. Peristaltic pump tubing wear requires that the blue filters connected to the diluent and rinse pumps should be changed every 9,000 cycles.
2. Inspect the peristaltic pump tubing. If it shows excessive wear, or it has been in service for 18,000 cycles, the tubing should be replaced. If the diluent or rinse pump tubing is changed, the blue filter associated with that pump should also be changed.
3. Check the aspirate and diluent syringes. If there is evidence of excessive leaking or if they have been in service for 35,000 cycles, they should be replaced.
4. Check the Hgb-blank voltage and adjust if necessary.
5. Ensure that the Verification section has been completed for any replacement procedures that have been performed.
6. Perform the **REPRODUCIBILITY AND CARRYOVER** function on the CALIBRATION MENU (Operator's Guide, under the Calibration heading in the Replace/Adjust section). Both these tests must *PASS*.
7. Run all levels of control and verify that they are within expected limits.

5.2 PMI RECOMMENDATIONS

The MD II is a low maintenance instrument that does not require a PMI. Those service organizations that will perform PMIs on this instrument can consider the following components and verifications for their procedure.

Components

Filters

The green fluid barriers and blue particle filters should be replaced on every PMI. The effectiveness of these filters is determined by environmental and instrument conditions more than by instrument cycle count.

Aged peristaltic pump tubing or contaminated diluent determine replacement of the blue particle filter. Diluter problems, especially those associated with the VIC, determine replacement of the green fluid barriers.

Peristaltic Pump Tubing

The peristaltic pump tubing should be changed every 18,000 instrument cycles. Find out the customer's usage rate to decide whether this tubing should be changed every PMI or not.

Polyurethane Tubing

Polyurethane tubing should be changed when it loses its elasticity. When the tubing becomes stiff and discolored it has lost its elasticity.

Syringes

The diluent and aspirate syringes should be changed every 35,000 instrument cycles or when by visual inspection you can see that it needs changing. Even though discoloration caused by rusting of the shaft may occur before 35,000 instrument cycles, performance should not be affected.

Cleaning

1. Remove the dust from the upper chassis using a vacuum or brush.
2. Remove the salt deposits from the bath area and shield.
3. Inspect the tubing and fitting connections. Remove any salt deposits and repair any leaks you find.
4. Bleach the baths and apertures.

Adjustment Procedures

1. Perform the Latex Gain Adjustment procedure (Heading 4.27).
2. Perform the AIM Adjustment procedure (Heading 4.28).
3. Perform the Hgb Preamp Adjustment procedure (Heading 4.29).

Verification Procedures

1. Perform the **REPRODUCIBILITY AND CARRYOVER** function found in the Calibration section of the Operator's Guide. Both these tests must *PASS*.
2. Have the customer run their controls.

6 **SCHEMATICS AND BLOCK DIAGRAMS**, 6.1-1

6.1 DOCUMENT CONTROL NUMBERS AND DESCRIPTIONS, 6.1-1

6.2 SCHEMATICS, 6.2-1

TABLES

6.1-1 DCNs and Descriptions for Schematics Included in This Manual, 6.1-1
6.1-2 DCNs and Descriptions for Schematics Not Included in This Manual, 6.1-1

6.1 DOCUMENT CONTROL NUMBERS AND DESCRIPTIONS

IMPORTANT Risk of instrument malfunction or erroneous results. Official schematics and drawings in this section will be revised only with revision of the manual. They will be current on the date of the first printing of a revision. Reprints between manual revisions will not be updated with current drawing revisions. It is the user's responsibililty to update these drawings between manual revisions

Table 6.1-1 includes Document Control Numbers (DCNs) and descriptions for the schematics/diagrams found in Heading 6.2, SCHEMATICS. Table 6.1-2 includes DCNs for schematics that are available but not included in this manual.

The schematics included in this chapter are updated to the latest revision level whenever this manual is revised. Because the schematics are not assigned figure numbers or page numbers, they cannot be included in the table of contents or the index.

Table 6.1-1 DCNs and Descriptions for Schematics Included in This Manual

DCN	Description
6321447	Timing Charts
6321448	Pneumatic/Hydraulic Layout
6321534	Linear Power Supply Card
6321553	AC Power/Vacuum Relay Card
6321564	Motor/Solenoid Driver Card
6321646	Electrical Interconnect Diagram

Table 6.1-2 DCNs and Descriptions for Schematics Not Included in This Manual

DCN	Description
6321108	Vacuum Sensor Card
6321634	DRA Card
6321690	Sensor Preamp Adapter Card
6321706	SPAD Card
6321709	Hgb Preamp Card
6321714	URA Card

6.2 SCHEMATICS

This section includes the schematics and/or diagrams for the:

- Pneumatic/Hydraulic Layout
- Timing Charts
- Electrical Interconnect Diagram
- Linear Power Supply Card
- AC Power/Vacuum Relay Card
- Motor/Solenoid Driver Card.

7 **TROUBLESHOOTING**, 7.1-1

7.1 TROUBLESHOOTING DIAGNOSTICS, 7.1-1
Customer Options Available for Troubleshooting, 7.1-1
Service Menu, 7.1-2

7.2 GENERATING A SERVICE REPORT, 7.2-1
The Screen Display, 7.2-1
The Printed Report, 7.2-1
AIM Criteria Results, 7.2-2
Hgb Data, 7.2-3
Sample Results - DO NOT REPORT, 7.2-3

7.3 SERVICE DIAGNOSTIC, 7.3-1

7.4 TROUBLESHOOTING ERROR MESSAGES, 7.4-1

7.5 TROUBLESHOOTING POWER-UP PROBLEMS, 7.5-1

ILLUSTRATIONS

7.2-1 Sample Screen Display, 7.2-1
7.2-2 Sample Printed Report, 7.2-2
7.2-3 Hgb Results Analysis, 7.2-4

7.5-1 Power-Up Troubleshooting Flowchart (part 1 of 2), 7.5-1
7.5-2 Power-Up Troubleshooting Flowchart (part 2 of 2), 7.5-2

TABLES

7.1-1 Diluter Functions Menu Options, 7.1-1
7.1-2 Service Menu Options, 7.1-2

7.3-1 Service Diagnostic Cycle, 7.3-1

7.4-1 Error Messages, 7.4-1

7.1 TROUBLESHOOTING DIAGNOSTICS

Customer Options Available for Troubleshooting

The Diluter Functions menu provides the customer and Service Representative a means of basic diluter troubleshooting. There are six functions provided on this menu and they are described in Table 7.1-1.

Table 7.1-1 Diluter Functions Menu Options

Function	Description	When to Use
CLEAR APERTURES	Performs an aperture burn or zap, similar to the zap performed during an aspiration cycle.	• As a first attempt at clearing a plugged aperture, perform several times.
DISPENSE LYSE	Dispenses 415 mL of lyse into the WBC bath. Note: There is no drain function tied to **DISPENSE LYSE**, so it is up to the operator to monitor and drain the WBC bath if necessary. Note that the lyse sensor (S9) is not used during this function.	• To manually prime the lyse system. • To check for bubbles in the lyse system. • To verify operation of lyse pump PM5. • In the Lyse Volume Adjustment/Verification procedure (see Heading 4.31).
DRAIN	Drains the baths.	• Primarily to drain fluid before removing the baths. • To verify the operation of waste pump, PM4, and solenoids 7 and 10.
RINSE	Primes the diluent reservoir system and fills both baths with fresh diluent. First, however, performs a drain to ensure the baths do not overflow, eliminating the need to **DRAIN** the baths before using **RINSE**.	• To verify the operation of rinse pump, PM3, and solenoid 11. • To help detect a plugged 10m filter (FLS2). • To check the operation of diluent pump, PM2, if it is used enough times to force a refill of the reservoir.
MIX	Operates by sending mixing bubbles to each bath in turn.	• To verify the operation of air/mix pump, PM1, and solenoid 12. • To observe plugs or leaks in fluid barrier FLS3 and solenoid 9.
CLEAN BATHS	Drains the baths, then prompts the operator to add a cleaning solution directly into the open baths. Use a dilute bleach solution. If COULTER CLENZ® concentrate is not available, use COULTER CLENZ cleaning agent.	• To clean the baths with a solution other than COULTER CLENZ concentrate (cleaning agent). • If the **CLEAR APERTURES** function was unsuccessful, to add bleach solution as a second step for attempting to clear a clogged aperture.

Service Menu

The Service menu contains six visible menu items. These are items the customer has access to but will not often use. They are of most use during troubleshooting and are discussed in Table 7.1-2. There is a seventh item, Service Diagnostic, that is hidden from the customer.

Table 7.1-2 Service Menu Options

Function	Description	When to Use
LATEX GAIN (for Coulter service personnel only)	Adjusts the RBC and WBC aperture current settings. Adjustment is necessary when the mean volumes are greater than 1.5 fL from the latex assay. See Heading 4.27, LATEX GAIN ADJUSTMENT.	To adjust the RBC and WBC aperture current settings to compensate for component and temperature variations. When the apertures, the Sensor Preamp Adapter card or the SPAD card are replaced.
REPLACE SYRINGE (for Coulter service personnel only)	Moves syringes to a middle-stroke position, making removal/replacement easier. Note: The power must be turned OFF during this procedure.	Each time the syringe bodies are removed.
PULSE TEST	Generates a string of pulses, feeds them into the SPAD card and generates a report giving counts, MCV and histograms. See Test Pulse Generator under Heading 2.5, DATA ACQUISITION.	To verify SPAD card operation when signal processing of pulse data is in question. Note: This test verifies inoperable or dead circuits on the SPAD card. It does not however, indicate how well the SPAD card deals with the complex pulse train of a real sample.
VOLTAGE READINGS	Displays a PASS/FAIL message for the +5 V, +12 V and +15 V power supplies. Also displays the aperture current settings and the Hgb voltage.	To verify the +5 V, +12 V and +15 V power supplies. To verify the aperture current settings. To troubleshoot/adjust Hgb voltage.
VACUUM ADJUST	Allows the operator to adjust the system count vacuum. Note: There is no system indicator for the high or raw-vacuum output of the vacuum pump.	When the instrument's count vacuum requires adjustment. To indicate vacuum while troubleshooting.
REVISION LEVELS	Determines the software revision level that is currently loaded by the instrument. Note: Although there are several hardware items listed, the hardware cannot indicate a revision level to the software.	To determine the software revision that is currently loaded by the instrument.
[no menu item displays on the screen] Service Diagnostic	A diluter table (or cycle) that energizes solenoids and the Probe/Wipe Traverse Assembly motors, one by one. This function is password protected and the password is 123. See Heading 7.3, SERVICE DIAGNOSTIC.	To troubleshoot diluter components. To verify solenoid, probe motor, traverse motor and traverse sensor operation.

7.2 GENERATING A SERVICE REPORT

The Service Report provides data about the previous aspirate cycle, whether it was a sample, a control or a calibrator. This data is not displayed on any customer screen or printout.

To access the Service Report, at the Main Menu select **5 SPECIAL FUNCTIONS ▸▸ 4 SUPERVISOR ▸▸ 7** [no menu item displays on the screen].

A partial report with Aperture Integrity Monitor (AIM) data is displayed on the screen, and if the Auto Print function is active, a more comprehensive report is automatically sent to the Printer.

The Screen Display

The top line of the display has two data entry points for RBC and WBC 26-percentile target values (Figure 7.2-1). For a description of what this screen displays, see the information under the next Heading, The Printed Report.

Figure 7.2-1 Sample Screen Display

```
RED TARGET    ~~~~    WHT TARGET    ~~~~
RED MEASURED  ~~~~    WHT MEASURED  ~~~~
RED CV        ~~.~~   WHT CV        ~~.~~
RED RATIO CV  ~~.~~   WHT RATIO CV  ~~.~~
```

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The Printed Report

If the Service Report function is accessed with Auto Print active, a report is automatically sent to the printer. An example of the printed report is shown in Figure 7.2-2. The information in Figure 7.2-2 follows the report, heading by heading, and describes the information contained in the report.

Figure 7.2-2 Sample Printed Report

```
                              Service Report

 Date: 06-18-93                          Time: 17:31


 AIM Criteria Results
 --------------------

                          Range                                      Range
 RBC Target(T)  2350                     WBC Target(T)  2375
 RBC Measured      0 0.935T - 1.045T     WBC Measured      0  0.950T - 1.070T
 RBC CV         0.00    0.5 - 4.0        WBC CV         0.00    0.50 - 4.00
 RBC Ratio CV   0.00    0.0 - 7.5        WBC Ratio CV   0.00    0.00 - 9.50
                                         WBC Ratio      0.00    0.15 - 1.00
 RBC Voteout  0                          WBC Voteout   0


 HGB DATA
 --------

 HGB Read #1      0  mV                  HGB Blank #1      0  mV
 HGB Read #2      0  mV                  HGB Blank #2      0  mV

 Sample Results - DO NOT REPORT
 ------------------------------

                          WBC    0.0   x10^3/uL
                          RBC   0.00   x10^6/uL
                          HGB    0.0   g/dL
                          MCV    0.0   fL
                          HCT    0.0   %

Notes:
  1- CBC parameters are for troubleshooting only, DO NOT REPORT RESULTS.
  2- CBC parameters are in US units.
  3- WBC Ratio CV is checked only if WBC is greater than 2.5 x10^3/uL.
  4- A Hemoglobin result of -1.0 indicates an incomplete computation for HGB.
  5- AIM Voteout Parameter: 0 - no or total voteout; 1, 2, 3 - The aperture
     number of a single voteout.
```

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AIM Criteria Results

During data accumulation, pulses are edited so that only good pulses are used to produce histograms. One output of the Editor circuit is the 26-percentile voltage. This voltage is a pulse width parameter that is representative of the travel time or flow through the aperture. An average 26-percentile voltage is measured for each of the 12 count periods that make up the instrument's data accumulation. This data is used along with the parameter data to determine abnormal aperture events, specifically clogs or partial clogs. A description of each line item follows. Specific values are not given for the acceptable ranges since they are subject to change with software revisions. Use the ranges given on the Service Report of the instrument you are troubleshooting.

Target (T): The expected 26-percentile voltage for most samples on a given instrument. The procedure to set target values can be found in Heading 4.28, AIM ADJUSTMENT.

Measured: The average 26-percentile voltage for the entire data accumulation. The acceptable limits are given on the report as a fraction or percentage of the instrument’s target: example 0.935T is 0.935 times the target value or 6.5% below the target value.

CV: The CV of the 12 count period, 26-percentile results.

Ratio: The ratio of good pulses (or pulses that are accepted by the Editor circuit) to all pulses counted.

Ratio CV: The ratio of good pulses to total pulses is calculated for each of the 12 count periods, then the CV of the 12 ratios is calculated.

Voteout: The 12 count periods are grouped into 3 sets of 4 count periods, each set being a logical aperture. If one "aperture" count is too far removed from the other two, it is "voted out" and its number is given. If there is no voteout or a total voteout, a zero is given. The report prints the logical aperture that voted out.

Hgb Data

To help investigate Hgb problems, the Hgb data collected by the instrument during data accumulation is provided in this section. This data, four readings in all, is the output of the Hgb Preamp card expressed in mV.

The Hgb parameter is a calculated comparison between a light transmittance reading of the sample referenced to a reading of clear diluent. Two readings are taken when the sample is in the bath and two are taken when clear diluent is in the bath. The diluent reading is referred to as the HGB Blank read, while the sample reading is referred to as the HGB read. Each reading is actually a series of 50 readings subjected to software filtering and takes about 1 ms to complete.

The HGB Blank #1 reading is taken on the sample prefill just before the aspirated sample is introduced to the WBC bath. The HGB Blank # 2 reading is taken on the original rinse just before the probe moves across to the aspirate position. The two Hgb readings are taken just before the sample is drained from the WBC bath toward the end of the cycle. There is a 1/2 second delay between the Hgb readings.

Analysis of the Hgb reading results is shown in flowchart form in Figure 7.2-3.

Sample Results - DO NOT REPORT

Several considerations for an AIM determination are based on the parameter results. If any single AIM criterion fails, the results are displayed with a single asterisk (*) following them. If however, more than one AIM criterion fails, the results are suppressed and instead a string of asterisks (*****) is displayed. Since an AIM Alert may suppress the actual results, you must obtain the Service Report if you need actual results. The actual results are included on the Service Report for diagnostic use only, and should not be reported.

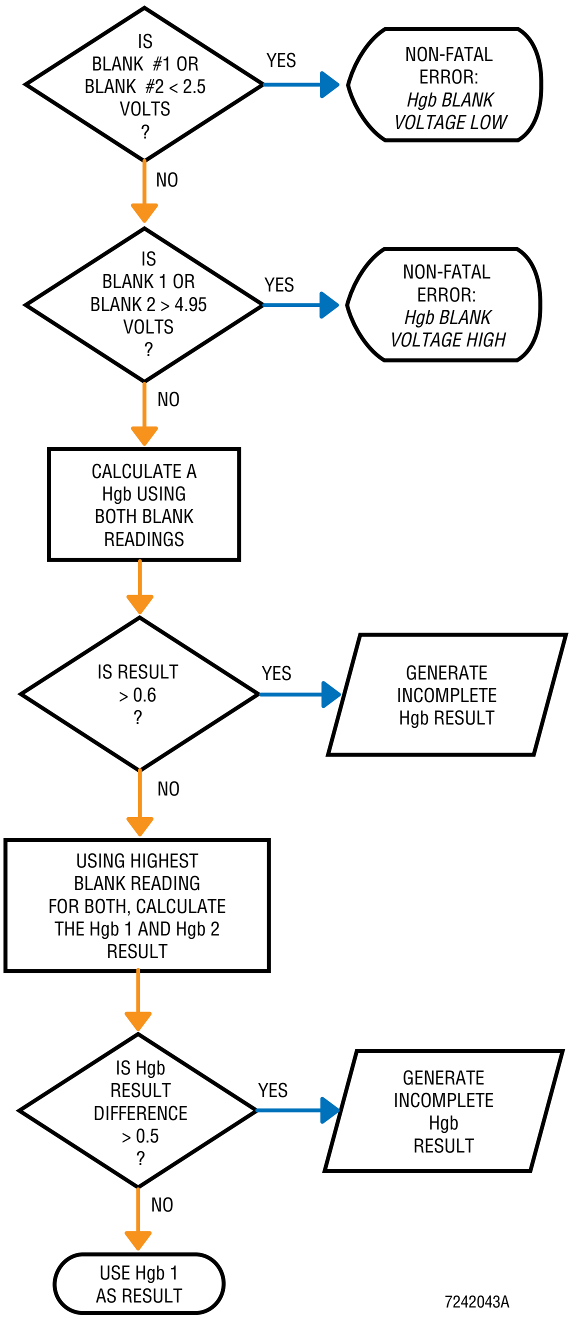
Below is a listing of AIM criteria based on parameter results.

- For WBC, ignore CV Ratio if WBC < 2.5×10^3
- RBC AIM if MCHC < 25 (ignore if Hgb incomplete)
- RBC AIM if MCHC > 40 (ignore if Hgb incomplete)
- RBC AIM if (Hgb x 3)/Hct < 0.8 (ignore if Hgb incomplete)
- RBC AIM if (Hgb x 3)/Hct > 1.2 (ignore if Hgb incomplete)

The instrument does not generate an AIM if:

- Hgb < 1.0 g
- If Hgb incomplete, RBC < 0.5×10^6
- For WBC and RBC, a complete voteout occurs
- For WBC, WBC < 1.0×10^3

Figure 7.2-3 Hgb Results Analysis



7.3 SERVICE DIAGNOSTIC

A Service Diagnostic diluter table (or cycle) has been included in the instrument. The table energizes solenoids and motors, one by one.

ATTENTION: Once you begin the cycle, you must advance completely through the table. Pressing the **Escape** key will not exit the cycle.

To begin the Service Diagnostic, at the Main Menu select **5 SPECIAL FUNCTION ▸▸ 5 SERVICE ▸▸ 7** [no menu item displays on the screen].

When the instrument prompts you for a password, type `123`.

After entering the password, solenoid LV1, the vacuum transducer vent valve located on the Vacuum Sensor card, is energized. A list of the components and the order in which they are energized is given in Table 7.3-1. To de-energize the current component and energize the next, press the **Aspirate** key.

Table 7.3-1 Service Diagnostic Cycle

Sequence	Component	Description - Function
1	LV1	Vents pressure transducer (located on the Vacuum Sensor card).
2	LV2	Vents VIC (located on the Vacuum Sensor card).
3	LV3	Switches between count and high vacuum for VIC.
4	LV4	Opens sweep-flow path.
5	LV5	Opens path between RBC aperture and VIC (count vacuum).
6	LV6	Opens path between WBC aperture and VIC (count vacuum).
7	LV7	Selects which bath to drain.
8	LV8	Opens path from probe wipe to VIC (high vacuum).
9	LV9	Selects LV12 (OFF) or WBC bath air/mix (ON).
10	LV10	Selects bath or VIC to drain.
11	LV11	Selects which bath receives rinse diluent.
12	LV12	Selects RBC bath mix (OFF) or lyse line air gap (ON).
13	LV13	Selects which bath gets prefill.
14	LV14	Switches diluent syringe between bath or probe/probe wipe.
15	LV15	Selects input/output for diluent syringe.
16	LV16	Switches dispense output between probe and probe wipe.
17		Moves sample aspirate probe to the aspirate position.
18		Moves sample aspirate probe to the WBC bath position.
19		Moves sample aspirate probe to the RBC bath position.
20		Moves sample aspirate probe to the down position.
21		Moves sample aspirate probe to the up position.

7.4 TROUBLESHOOTING ERROR MESSAGES

Table 7.4-1 Error Messages

Error Message	Code	Description/Possible Fault
Aspirate Syringe Failure	026	When the syringe is sent to the home position, it stops on sensor. To make sure it gets to the sensor, it is allowed 40 extra steps. This means that if the motor is sent down a total of 3000 steps, it is sent up 3040 steps. The sensor is checked when enough time elapses to complete travel, and if it does not sense the flag, *ERROR DETECTED (026) Aspirate Syringe Failure* is displayed on the screen.
	027	A check of the sensor state is made after every downward movement of the syringe. If the syringe is sensed in the top position, *ERROR DETECTED (027) Aspirate Syringe Failure* is displayed on the screen.
Copy Protection Violation	018	The hardware for an 8/10 parameter instrument and a 16/18 parameter instrument are different. If you power up an 8/10 parameter instrument with 16/18 parameter software, the software reverts to the instrument's software (8/10 parameter). If you attempt to use resource files from a 16/18 parameter instrument, on an 8/10 parameter instrument, after power up, *ERROR DETECTED (018) Copy Protection Violation* is displayed on the screen. If this occurs, the files from different instrument type Program Disks were mixed or a Program Disk from a different instrument type was used after initial power up.
Count Period Timeout	020	The MD II Series accumulates 12 seconds of count and histogram data for analysis, collected in 1-second increments. The DMA process used to channelize histogram data controls the time, but a separate software timer is used to double check it. If data accumulation is still taking place after 1.2 seconds, *ERROR DETECTED (020) Count Period Timeout* is displayed on the screen. The DMA transfer is between the SPAD card and the motherboard.
CPU Fatal Error	013	The CPU on the AT motherboard signals the user software that it has detected a processor fault, such as an illegal processor instruction or a divide by zero request. When any error signal is received from the processor, *ERROR DETECTED (013) CPU Fatal Error* is displayed on the screen. This is usually a motherboard problem. However, if the software requests the CPU to divide by zero, the software is at fault.
Diluent Syringe Failure	028	When the syringe is sent to the home position, it stops on sensor. To make sure it gets to the sensor, it is allowed 40 extra steps. This means that if the motor is sent down a total of 3000 steps, it is sent up 3040 steps. The sensor checks when enough time elapses to complete travel, and if it does not sense the flag, *ERROR DETECTED (028) Diluent Syringe Failure* is displayed on the screen.
	029	A check of the sensor state is made after every downward movement of the syringe. If the syringe is sensed in the top position, *ERROR DETECTED (029) Diluent Syringe Failure* is displayed on the screen.

Table 7.4-1 Error Messages *(Continued)*

Error Message	Code	Description/Possible Fault
DRA Board Failure	003	When a stepper motor is set in operation, the DRA card uses a hardware timer to control the task. When the task is completed, the DRA card generates an interrupt request signaling that the task is complete. An independent software timer is allocated whenever a motor is given a task. This timer checks after 30 seconds, and if the interrupt signaling completion of the task has not been received, *ERROR DETECTED (003) DRA Board Failure* is displayed on the screen.
Hgb Blank Voltage High	Non-fatal Error	Two Hgb-blank readings are taken during a sample cycle. If the voltage received during one of the readings is greater than 4.95 V, *Hgb Blank Voltage High* is displayed on the screen.
Hgb Blank Voltage Low	Non-fatal Error	Two Hgb Blank readings are taken during a sample cycle. If the voltage received during one of the readings is less than 2.5 V, *Hgb Blank Voltage Low* is displayed on the screen.
Insufficient RAM	006	The system software dynamically allocates and deallocates memory as required. If an attempt is made to allocate memory for a task and there is not enough memory available, *ERROR DETECTED (006) Insufficient RAM* is displayed on the screen.
Keypad Failure	010	This error is currently not used by the system. If software is implemented to check the hardware on the URA card that controls the keypad input, this is the error code that would be used to indicate a problem. This error is not called by the software, but its code is in the list of error messages used when an error occurs. If the message is displayed on the screen, program execution has lost its way and the error should be treated as a *Software Fatal Error.*
Power Supply Failure	014	The MD II has an internal DVM function that does a voltage check of the +15 V, +5 V and +12 V power supplies. This function is called during the self-test portion of power up and just before results are displayed from a sample, control, calibration, startup or latex cycle. The DVM function is live, that is, it reports on the power quality at the time the function is called. It would not report any failure if the power momentarily dropped out earlier in the cycle. If a failure is returned by the DVM function call, *ERROR DETECTED (014) Power Supply Failure* is displayed on the screen.
	015	The MD II does a voltage check of the +24 V power supply at various times. As with the DVM check, this function is called during the self-test portion of power up and just before results are displayed from a sample, control, calibration, startup or latex cycle. It is also called before reporting an Hgb-blank error, a vacuum error or any sensor error involving a motor. This includes the two errors for each syringe, the three horizontal traverse position errors and the two probe vertical position errors. If there is no +24 V, the motor does not operate, but the problem is not with the motor or sensor circuit, so this ensures that a misleading error is not generated.

Table 7.4-1 Error Messages *(Continued)*

Error Message	Code	Description/Possible Fault
Power Supply Failure	015	The +24 V function checks the state of two latches. One latch is tied to the POWERFAIL signal from the +24 V power supply, and the other is controlled by the Overload Timer circuit on the Motor/Solenoid Driver card. If these latches are set at any time after the last +24 V check, the current +24 V check generates an *ERROR DETECTED (015) Power Supply Failure* error message. For more information about these circuits, see Motor/Solenoid Driver Card under Heading 2.4, SYSTEM CONTROL.
Probe Mechanism Failure		Probe mechanism movement is controlled by the mechanism stopping at a sensors. There are five sensors, one at each of the three horizontal positions, one at the top vertical position and one at the bottom of the vertical position. Diluter tables send the probe 40 steps more than necessary for horizontal movement and 15 steps more than necessary for vertical movement. The probe must travel within 110 steps of its destination or an error is generated. This description applies to all the Probe Mechanism error codes.
	030	When the software is informed that the movement is completed, it checks the sensor state. If the probe is not at the **upper position sensor**, or the step count is too low, *ERROR DETECTED (030) Probe Mechanism Failure* is displayed on the screen. Note: See initial description for more information.
	031	When the software is informed that the movement is completed, it checks the sensor state. If the probe is not at the **lower position sensor**, or the step count is too low, *ERROR DETECTED (031) Probe Mechanism Failure* is displayed on the screen. Note: See initial description for more information.
	032	When the software is informed that the movement is completed, it checks the sensor state. If the probe is not at the **sensor over the WBC bath**, or the step count is too low, *ERROR DETECTED (032) Probe Mechanism Failure* is displayed on the screen. Note: See initial description for more information.
	033	When the software is informed that the movement is completed, it checks the sensor state. If the probe is not at the **sensor over the RBC bath**, or the step count is too low, *ERROR DETECTED (033) Probe Mechanism Failure* is displayed on the screen. Note: See initial description for more information.
	034	When the software is informed that the movement is completed, it checks the sensor state. If the probe is not at the **sensor in the aspirate position**, or the step count is too low, *ERROR DETECTED (034) Probe Mechanism Failure* is displayed on the screen. Note: See initial description for more information.

Table 7.4-1 Error Messages *(Continued)*

Error Message	Code	Description/Possible Fault
RAM Drive Failure	038	During system boot, Virtual RAM (VRAM) drives are created. If the system was unable to create a drive, *ERROR DETECTED (038) RAM Drive Failure* is displayed on the screen. To create a VRAM drive, you must put the proper line in the CONFIG.SYS file. This means that the drive is created very early in the boot sequence. High memory, configured as extended memory, is used for the VRAM drive. Problems could occur with the disk boot process or the BIOS settings (especially where RAM is concerned) or with the RAM itself. Assuming a good disk, the BIOS on the MD II is self-configuring, so the most likely problem is with RAM.
Software Fatal Error	037	*ERROR DETECTED (037) Software Fatal Error* is displayed on the screen when execution of the instrument software has reached an area in the software that it should never get to. This is in effect, a software safety net.
Software Timer Error	021	At various times during program execution, software timers are allocated to ensure that events perform as expected. If the system is unable to allocate a timer, *ERROR DETECTED (021) Software Timer Error* is displayed on the screen.
SPAD Board Failure	001	Currently this error is not used by the system.
	004	*ERROR DETECTED (004) SPAD Board Failure,* indicates an overflow of a channel buffer. The RBC and WBC channeling sections have 16K buffers, while the Plt uses an 8K buffer. When too many pulses are processed, this error is displayed on the screen.
	039	During an A/D conversion on the SPAD card, a timer checks the time it takes to complete the conversion. If the conversion does not complete in approximately 10 µs, *ERROR DETECTED (039) SPAD Board Failure* is generated.
System Disk File Corrupt	005	If the system is unable to load a resource file from a diskette, *ERROR DETECTED (005) System Disk File Corrupt* is displayed on the screen.
	012	When the system powers up, it searches for a good system configuration either in CMOS or from the PD.DAT file on the Program Disk and then attempts to make them the same. *ERROR DETECTED (012) System Disk File Corrupt* is displayed on the screen if both configuration sources are bad or if the system cannot write a new PD.DAT file to disk. See User Resource Adapter (URA) Card under Heading 2.4, SYSTEM CONTROL for more information about how CMOS data is handled on power up.
	016	*ERROR DETECTED (016) System Disk File Corrupt* is displayed on the screen when the system cannot load a Printer report template file from the Program Disk.
	019	The system does a CRC check whenever it loads a file from the floppy drive. *ERROR DETECTED (019) System Disk File Corrupt* is generated whenever the CRC check fails.

Table 7.4-1 Error Messages *(Continued)*

Error Message	Code	Description/Possible Fault
Unable to Create INF File	Non-fatal Error	*Unable to Create INF File* is displayed on the screen when the system attempts to create an INF file and cannot. This message does not stop the system or the report for the sample being analyzed. It is merely a message for the user's information. Creation of the INF file occurs only if SW1-2 of the URA card is ON. This should only be turned ON if there is a hard drive present for INF files to be stored on. With no hard drive, INF files are stored to a Virtual RAM drive. Available memory runs out in about 10 samples and *Unable to Create INF File* is generated. Another reason INF files are not created is that the system date or time is earlier than the date or time recorded on the last INF file. *Unable to Create INF File* is displayed on the screen, allowing you to continue running with no adverse effects.
Unable to Sense Diluent Level	017	During power up, the diluent reservoir is checked for fluid and for sensor integrity. The reservoir is drained and overfilled. If the instrument cannot sense a lack of diluent when drained or the presence of diluent when overfilled, *ERROR DETECTED (017) Unable to Sense Diluent Level* is displayed on the screen.
URA Board Failure	002	Currently, this error is not used by the system. This error is not called by the software, but its code is in the list of error messages used when an error occurs. If the message is displayed on the screen, program execution has lost its way and the error should be treated as a *Software Fatal Error*.
	008	This error indicates that the software detected a failure of the Analog Multiplexer circuit on the URA card. The system selects a multiplexer channel, then the multiplexer is read to see if the channel is selected. If the channel is not selected, *ERROR DETECTED (008) URA Board Failure* is displayed on the screen.
	009	The system software uses a timer when it gives a conversion task to the A/D converter on the URA card. If the conversion does not complete in the allotted time, *ERROR DETECTED (009) URA Board Failure* is displayed on the screen. This A/D converter is used for only one task in the MD II, the DVM check. Any problem would have to be on the URA card itself.
URA CMOS Failure	011	*ERROR DETECTED (011) URA CMOS Failure* is displayed on the screen when the CMOS image is altered after power up. This error is displayed on the screen whenever the CMOS data is not correct. The power-up routines correct the CMOS image or generates an *ERROR DETECTED (012) System Disk File Corrupt* error message if a correction could not be made.
Vacuum Out of Range	Non-fatal Error	The system count vacuum is recorded during each of the 12 count periods. If one of these readings is outside of the 5.83 - 6.17 in. Hg limits, *Vacuum Out of Range* is displayed on the screen.

7.5 TROUBLESHOOTING POWER-UP PROBLEMS

The flowchart in Figure 7.5-1can help you troubleshoot when the instrument does not reach the Main Menu on power up.

Figure 7.5-1 Power-Up Troubleshooting Flowchart (part 1 of 2)

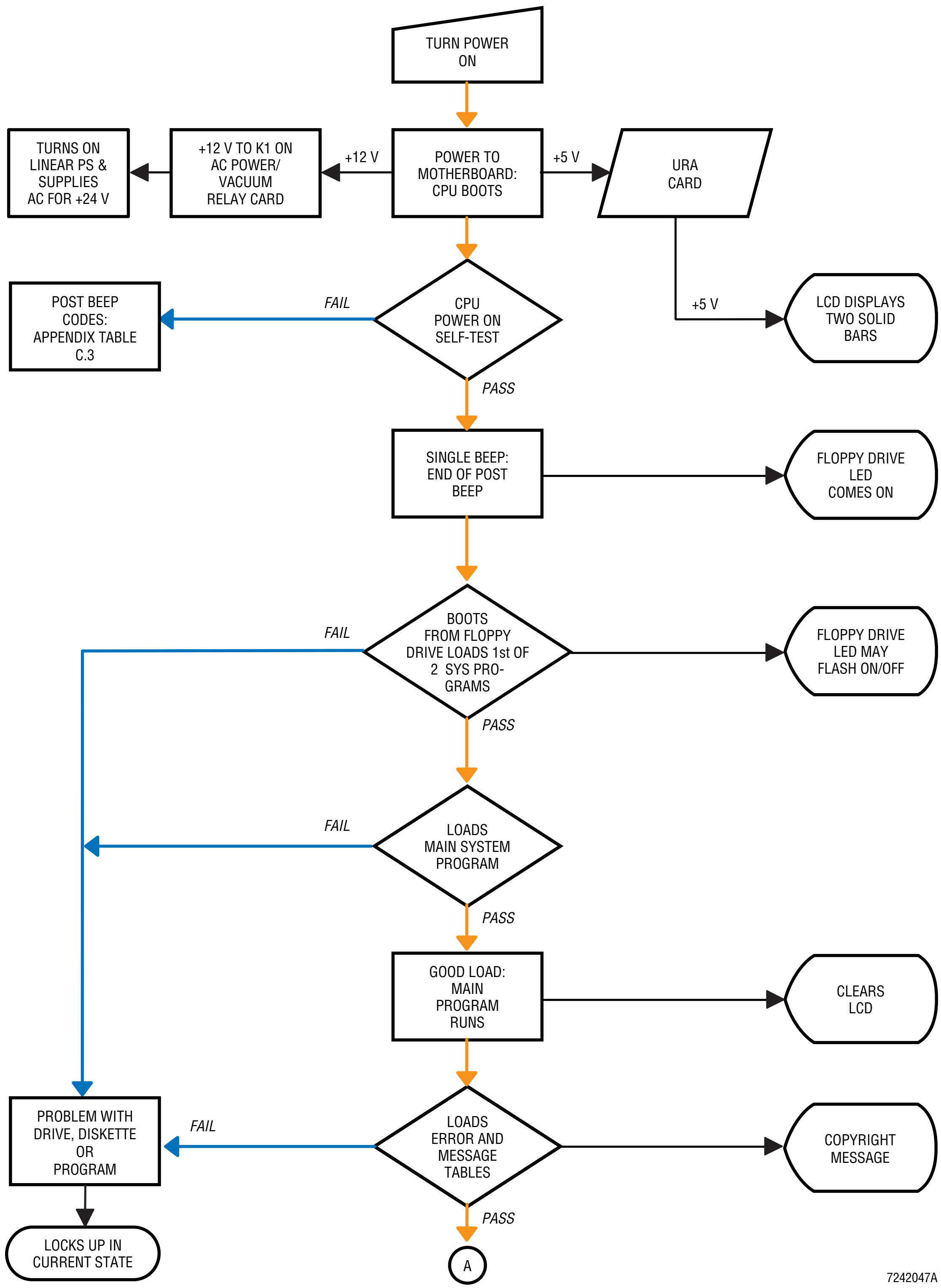
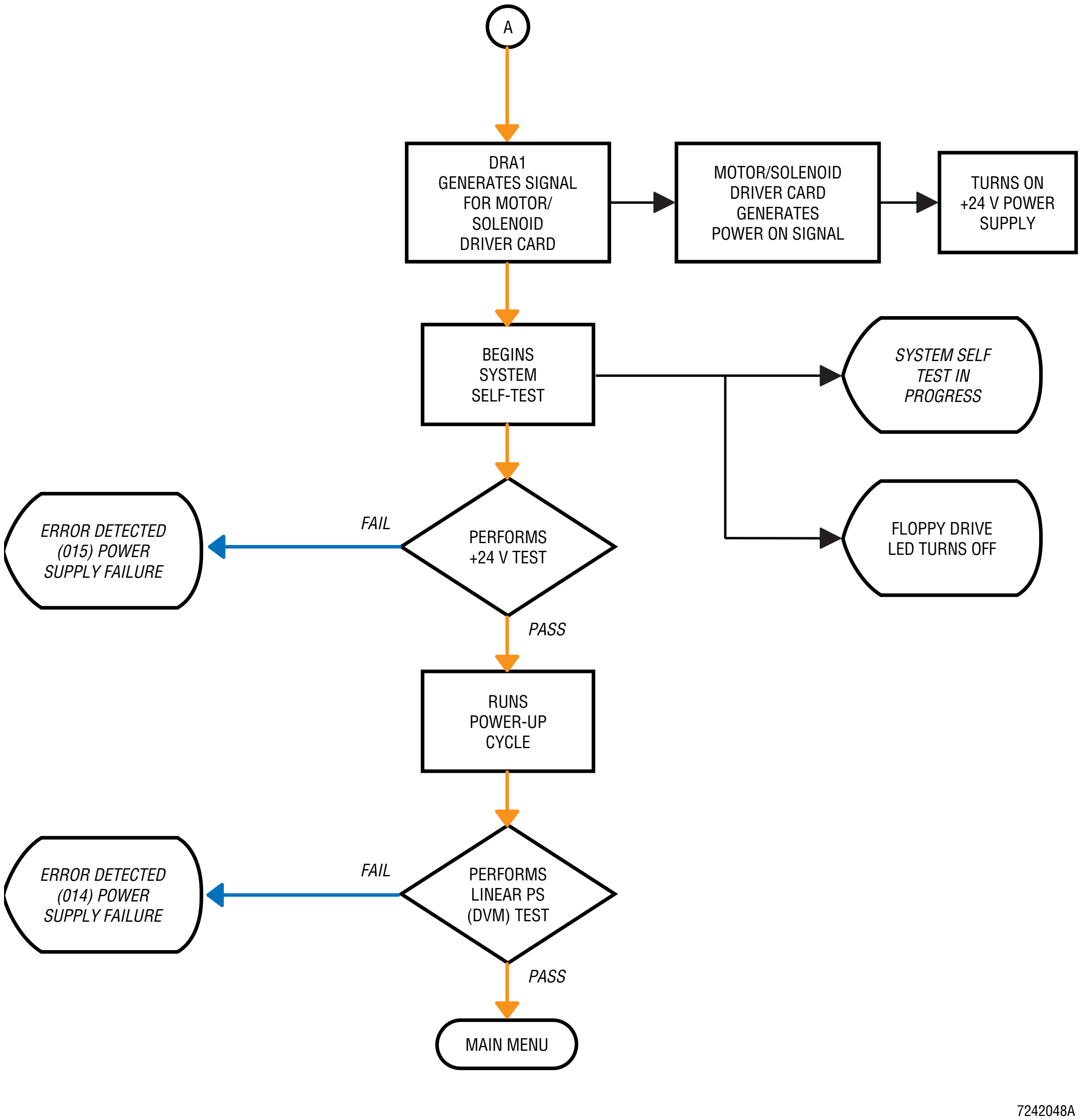


Figure 7.5-2 Power-Up Troubleshooting Flowchart (part 2 of 2)



8 **PARTS LISTS**, 8.1-1

8.1 MASTER PARTS LISTS, 8.1-1

8.2 ILLUSTRATED PARTS, 8.2-1

ILLUSTRATIONS

8.2-1 MD II, Lower Chassis, Left Side View (See Table 8.2-1), 8.2-1
8.2-2 MD II, Front View (See Table 8.2-2), 8.2-2
8.2-3 MD II, Top View into Lower Chassis (See Table 8.2-3), 8.2-3
8.2-4 MD II, Upper Chassis (See Table 8.2-4), 8.2-4
8.2-5 MD II, Back View (See Table 8.2-5), 8.2-5
8.2-6 Traverse Assembly (See Table 8.2-6), 8.2-6
8.2-7 Diluter Assembly (See Table 8.2-6), 8.2-8
8.2-8 Syringe Assembly (See Table 8.2-8), 8.2-10
8.2-9 Peristaltic Pump Assembly (See Table 8.2-9), 8.2-12

TABLES

8.1-1 Cables, 8.1-1
8.1-2 Lower Chassis, 8.1-2
8.1-3 Peripherals and Support, 8.1-5
8.1-4 Upper Chassis, 8.1-6
8.1-5 Miscellaneous Hardware, 8.1-7

8.2-1 MD II, Lower Chassis, Left Side View (See Figure 8.2-1), 8.2-1
8.2-2 MD II, Front View (See Figure 8.2-2), 8.2-2
8.2-3 MD II, Top View into Lower Chassis (See Figure 8.2-3), 8.2-3
8.2-4 MD II, Upper Chassis (See Figure 8.2-4), 8.2-4
8.2-5 MD II, Back View (See Figure 8.2-5), 8.2-5
8.2-6 Traverse Assembly (See Figure 8.2-6), 8.2-7
8.2-7 Diluter Assembly (See Figure 8.2-7), 8.2-9
8.2-8 Syringe Assembly (See Figure 8.2-8), 8.2-11
8.2-9 Peristaltic Pump Assembly (See Figure 8.2-9), 8.2-13

8.1 MASTER PARTS LISTS

These parts lists are in part number order by category. The categories are:

- Cables
- Lower Chassis
- Peripherals and Support
- Upper Chassis
- Miscellaneous Hardware.

Table 8.1-1 Cables

Part No.	Description	Figure	Item
6027225-5	Cable, main ac power cable to instrument	8.2-5	10
6027767-2	Cable, power line cord, ac diluter to analyzer	8.2-5	2
6028504-7	Cable, Centronics parallel Printer, 10 ft	8.2-5	1
6028257-9	Cable, RS-232, 25 to 9-pin, used to check Host Interface		not shown
6028265-0	Cable, ground, used on bath and valve shields		not shown
6028337-1	Cable, MSMC and DRA card to Motor/Solenoid Driver card		not shown
6028467-2	Cable, interface between A/B switchbox and MD II, 6 ft		not shown
6028518-7	Cable, ribbon, motherboard to serial 1 connector		not shown
6028522-5	Cable, ribbon, motherboard to parallel connector		not shown
6028597-7	Cable, Probe/Opto card, Flex Connect card	8.2-6	4
6028668-0	Cable, solenoid extension		not shown
6028669-8	Cable, waste pickup tube, level sense	8.2-1	8
6028672-8	Cable, AIM SPAD card to URA card		not shown

Table 8.1-2 Lower Chassis

Part No.	Description	Figure	Item
1017541-1	Reservoir, diluent (uses cover, PN 1019609-4)	8.2-1	1
1019609-4	Cover, for diluent reservoir (PN 1017541-1)	8.2-1	2
1022803-4	Housing, 2-port manifold for diluent syringe, molded		not shown
1020601-4	Housing, 3-port manifold for aspirate syringe, molded	8.2-8	10
1021228-6	Fitting, top of aspirate and diluent syringe block	8.2-8	7
1022081-5	Fitting, black plastic feedthrough used on diluter bulkheads		not shown
1022814-0	Housing, 2-port manifold for diluent syringe, machined	8.2-8	9
1022827-1	Clip, wire, used to retain probe wipe housing	8.2-6	13
1022895-6	Spool, sweep-flow tubing retainer, molded	8.2-7	4
1022944-8	Spool, machined version of above, use until molded part available	8.2-7	4
1305019-8	Connector, ac input connector and filter		not shown
2004013-1	Counter, instrument cycle	8.2-2	11
2121439-6	Connector, ac cable to upper chassis		not shown
2523083-3	Seal, rubber ring, for stepper motor	8.2-9	13
2523618-1	Syringe, glass, 100 µL 1%, aspirate	8.2-2	4
2523628-9	Gear, used on lead screw, syringe and traverse motors	8.2-6 8.2-8	10 2
2523630-1	Belt, syringe lead screw drive	8.2-8	3
2523638-6	Syringe, glass, 5.0 mL 1%, diluent	8.2-2	5
2523793-5	Screw, syringe lead screw and housing assembly	8.2-8	15
2523795-1	Hinge, bath shield		not shown
2523805-2	Hinge, diluent reservoir door		not shown
2523809-5	Belt, traverse horizontal drive	8.2-6	3
2527674-4	Hinge, left side, panel		
2827024-1	Screw, 6-32 setscrew for peristaltic pump spool	8.2-9	4
2840053-5	Magnet, diluent reservoir door, catch	8.2-1	3
2840060-8	Plate, diluent reservoir door, magnetic strike	8.2-1	13
2840068-3	Magnet, front door and left side, catch	8.2-1	11
2851121-3	Plate, front door and left side, magnetic strike	8.2-1	14
2851898-6	Foot, rubber		not shown
3202220-1	Tubing, sweep-flow (13 ft needed)	8.2-7	5
3213208-1	Tubing, PharMed®		not shown
3213214-6	Tubing, silicon, peristaltic pump	8.2-9	6
3230005-7	Tubing, 3-piece, probe wipe (34 in. needed)	8.2-6	20
3814255-1	Filter, Hgb, 525 nm (green), optical		not shown

Table 8.1-2 Lower Chassis *(Continued)*

Part No.	Description	Figure	Item
4004092-7	Power supply, +24 V switching	8.2-3 8.2-5	1 6
4717896-7	Resistor, 25 W, wire-wound, 15 Ω for motor drivers	8.2-5	7
5102018-9	Fuse, 4 A, 250 V, (F1 and F2 at back, 120 V instrument)	8.2-5	9
5102021-9	Fuse, 2 A, 250 V, (F1 and F2 at back, 220 V instrument)	8.2-5	9
5102084-7	Fuse, 0.4 A, AC Power/Vacuum Relay card, vacuum pump		not shown
6214108-5	Valve, small check		not shown
6232075-3	Valve, 3-way solenoid, air (LV9 and LV12)	8.2-2	10
6232076-1	Filter, green fluid barrier	8.2-1 8.2-2	9 7
6232246-2	Fitting, plastic reducer, peristaltic pump tubing	8.2-9	5
6232259-4	Fitting, 0.093 Y		not shown
6232382-5	Nut, reagent bulkhead Luer fitting		not shown
6232463-5	Fitting, aspirate, front of syringe mount	8.2-8	11
6232477-5	Fitting, nylon (use on machined baths)		not shown
6232483-0	Fitting, syringe block Luer for syringe connection	8.2-8	6
6232497-0	Spacer, red plastic indicator for waste Luer fitting	8.2-1	6
6232498-8	Spacer, white plastic indicator for lyse Luer fitting	8.2-1	4
6232499-6	Spacer, blue plastic indicator for diluent Luer fitting	8.2-1	5
6232502-0	Fitting, tubing Luer for reagent connection	8.2-1	7
6232503-8	Fitting, bulkhead Luer for reagent connection		not shown
6232510-1	Fitting, lyse pump, ferrule and threaded nut	8.2-2	9
6232554-2	Filter, fluid, 10 μ, blue	8.2-1	10
6232560-7	Valve, 3-way solenoid, poppet (Vacuum Sensor card)		not shown
6232564-0	Fitting, barbed union, 0.062		not shown
6232628-0	Regulator, vacuum	8.2-2	3
6232718-9	Valve, Angar 2-way solenoid, fluidic	8.2-7	2
6705721-0	Card, Vacuum Sensor	8.2-3	5
6705777-5	Aperture block, RBC	8.2-7	7
6705778-3	Aperture block, WBC	8.2-7	19
6706032-6	Card, Linear Power Supply	8.2-3 8.2-5	2 8
6706065-2	Card, AC Power/Vacuum Relay	8.2-3	3
6706077-6	Card, Motor/Solenoid Driver	8.2-3	11
6706113-6	Card, Surge/Transient Suppressor		not shown
6706150-1	Card, Sensor Preamp Adapter	8.2-3	8

Table 8.1-2 Lower Chassis *(Continued)*

Part No.	Description	Figure	Item
6706161-6	Card, Probe/Opto Sensor	8.2-6	8
6706166-7	Card, Flex Connect	8.2-3	10
6706202-7	Card, Solenoid Interconnect	8.2-3	9
6706254-0	Sensor, lyse fluid detector assembly		not shown
6706321-0	Guide, traverse housing, lower, machined		not shown
6706322-8	Rack, traverse housing with pin		not shown
6706323-6	Card, Hgb Preamp	8.2-3	7
6805010-3	Sensor, Hgb photodetector	8.2-7	13
6805019-7	Sensor, optical sensor assembly used on traverse		not shown
6805022-7	Pump, lyse solenoid	8.2-2	8
6805024-3	Sensor, optical sensor assembly used on syringe module		not shown
6805025-1	Sensor, diluent level sense	8.2-1	12
6805033-2	LED, Hgb	8.2-7	11
6805068-5	Motor, stepper assembly, used throughout instrument	8.2-8 8.2-9	1 2
6805080-4	Chamber, vacuum isolator (VIC)	8.2-7	3
6805119-3	Motor, probe, vertical position stepper motor assembly	8.2-6	22
6805124-0	Housing, probe wipe, molded	8.2-6	17
6805149-5	Housing, Aperture Electrode module		not shown
6805226-2	Bath, RBC/ WBC assembly, machined		not shown
6805247-5	Bath, RBC/WBC assembly, molded (use when available)	8.2-7	7
6855834-4	Gear, traverse idler pulley	8.2-6	9
6856899-4	Pump, vacuum, 220 V, 50/60 Hz	8.2-3	6
6858007-2	Pump, vacuum, 115 V, 50/60 Hz	8.2-3	6
6859540-1	Transformer, Linear Power Supply card	8.2-3	4
6859596-7	Syringe Assembly		not shown
6859598-3	Probe/Wipe Traverse Assembly		not shown
6859650-5	Spool, peristaltic pump tubing	8.2-9	3
6859707-2	Housing, traverse	8.2-6	11
6859716-1	Housing, probe wipe, machined	8.2-6	17
6859741-2	Probe, aspirate assembly	8.2-6	16
6859786-2	Gear, traverse belt tensioner	8.2-6	37
9921373-6	Holder, fuse, for F1 and F2 at back	8.2-5	9

Table 8.1-3 Peripherals and Support

Part No.	Description	Figure	Item
1601018-9	Adhesive, LOCTITE 242, THREADLOCKE2		not shown
1601065-1	Adhesive, LOCTITE 222, THREADLOCKE2		not shown
1604007-0	Lubricant, DOW CORNING 33, silicon grease		not shown
2016511-1	Ribbon, black, for CITIZEN GSX-190 and GSX-200		not shown
2016555-3	Stand, dot matrix Printer		not shown
2016577-4	Switchbox, A/B parallel Printer switcher		not shown
2016583-9	Printer, CITIZEN GSX-190, parallel, 110 V	8.2-5	11
2016584-7	Printer, CITIZEN GSX-190, parallel, 220 V	8.2-5	11
2016671-1	Printer, ticket, Epson TM-290P	8.2-5	5
2016717-3	Ribbon, ink cassette, for Epson TM-290P Printer		not shown
2121864-2	Adapter, ASTM host interface		not shown
3202205-7	Tubing, red stripe for waste output		not shown
3202209-0	Tubing, blue stripe for diluent input		not shown
3202221-9	Tubing, EVA for lyse input		not shown
4004103-6	Power supply, 24V, for Epson TM-290P Printer, Universal	8.2-5	4
5450104-8	Tool, pin extractor, Mini MATE-N-LOK®		not shown
6415128-2	Software, ASTM Host verification disk, Revision 1.2		not shown
6417372-3	Software, MD II - 8 program disks, English, Revision 1.3		not shown
6417373-1	Software, MD II - 10 program disks, English, Revision 1.3		not shown
6417374-0	Software, MicroDiff II - 16 program disks, English, Revision 1.3		not shown
6417375-8	Software, MicroDiff II - 18 program disks, English, Revision 1.3		not shown
6417384-7	Software, MicroDiff II - 18 program disks, German, Revision 1.3		not shown
6417387-1	Software, MD II - 8 program disks, German, Revision 1.3		not shown
6417388-0	Software, MicroDiff II - 18 program disks, French, Revision 1.3		not shown
6417389-8	Software, MicroDiff II - 16 program disks, French, Revision 1.3		not shown
6417390-1	Software, MD II - 10 program disks, French, Revision 1.3		not shown
6417391-0	Software, MD II - 8 program disks, French, Revision 1.3		not shown
6417392-8	Software, MicroDiff II - 18 program disks, Spanish, Revision 1.3		not shown
6417394-4	Software, MD II - 10 program disks, Spanish, Revision 1.3		not shown
6417395-2	Software, MD II - 8 program disks, Spanish, Revision 1.3		not shown
6417396-1	Software, MicroDiff II - 18 program disks, Japanese, Revision 1.3		not shown
6417399-5	Software, MD II - 8 program disks, Japanese, Revision 1.3		not shown
6417410-0	Software, MicroDiff II - 18 program disks, Italian, Revision 1.3		not shown
6605010-6	Pickup tube, diluent, 10 L		not shown
6605236-2	Pickup tube, lyse		not shown

Table 8.1-3 Peripherals and Support *(Continued)*

Part No.	Description	Figure	Item
6856742-4	Pickup tube, waste		not shown
6857371-8	Particles, latex aperture gain		not shown
6913269-3	Kit, Host Communication, with adapter and manual		not shown
6914956-1	Tool, lyse volume-adjustment measuring vial kit, MD Series		not shown
6915032-2	Software, service replacement Ticket Key Disk Kit		not shown

Table 8.1-4 Upper Chassis

Part No.	Description	Figure	Item
1023067-5	Shield, fish paper, for upper chassis card cables		not shown
2016503-1	Drive, 3.5 in., 1.44 MB floppy disk	8.2-4	8
2016601-1	Keypad, membrane touch pad (use while available)	8.2-2	2
2016722-0	Keypad, membrane touch pad, tactile response	8.2-2	2
2523685-8	Hinge, upper chassis mounting	8.2-5	3
4004079-0	Power supply, CPU switching	8.2-4	6
6706089-0	Card, DRA (Diluter Resource Adapter)	8.2-4	2
6706165-9	Card, SPAD (Sensor Processing Adapter with Diagnostics)	8.2-4	3
6706170-5	Card, URA (User Resource Adapter)	8.2-4	1
6858009-9	Speaker, CPU subassembly	8.2-4	9
7000156-0	CPU, 386 motherboard	8.2-4	10
7000168-3	Display, LCD main	8.2-2	1

Table 8.1-5 Miscellaneous Hardware

Part No.	Description	Figure	Item
1022792-5	Washer, rubber, used to mount old style Hgb LED & photodiode	8.2-7	14
1022916-2	Bushing, front aperture bath clamp	8.2-7	10
1023330-5	Screw, special, used to mount MicroDiff II hardware key		not shown
2121421-3	Contact, socket, MTE		not shown
2121423-0	Connector, 2-pin plug, MTE (Angar solenoid valves)		not shown
2121691-7	Connector, 6-pin, mini univ MATE-N-LOK	8.2-9	12
2121692-5	Contact, socket, mini univ MATE-N-LOK, 22-18 AWG		not shown
2121718-2	Contact, pin, mini univ MATE-N-LOK, 20-16 AWG		not shown
2121719-1	Contact, socket, mini univ MATE-N-LOK, 26-22 AWG		not shown
2121734-4	Connector, 5-pin plug, MTE		not shown
2121742-5	Connector, 6-pin panel, mini univ MATE-N-LOK		not shown
2121743-3	Connector, 2-pin panel, mini univ MATE-N-LOK		not shown
2121744-1	Connector, 2-pin plug, mini univ MATE-N-LOK		not shown
2121788-3	Contact, pin, mini univ MATE-N-LOK, 26-22 AWG		not shown
2121812-0	Connector, 4-pin plug, mini univ MATE-N-LOK		not shown
2121831-6	Connector, 4-pin panel, mini univ MATE-N-LOK		not shown
2121927-4	Connector, 1-pin plug, mini univ MATE-N-LOK	8.2-7	15
2121928-2	Connector, 1-pin cable, mini univ MATE-N-LOK	8.2-7	17
2512120-1	O-ring, small, aperture/aperture module seal		not shown
2523625-4	Bearing, syringe lead screw (used top and bottom)	8.2-8	4
2523644-1	Spring, lead screw tension	8.2-8	13
2523657-2	O-ring, aperture/aperture bath seal	8.2-7	16
2804005-9	Screw, 4-40 x 1/4 in.	8.2-7	12
2806125-1	Screw, 6-32 x 0.38 in. HEX head, used to fasten syringe plunger		not shown
2808069-7	Screw, pan head, 8-32 x 0.56 in.	8.2-8	19
2810026-4	Screw, machine, 10-32 x 0.62 in.	8.2-9	8
2810047-7	Screw, 10-32 x 1.5 in. pan head Phillips	8.2-8	22
2822003-1	Nut, HEX, 4-40, used to fasten optical sensor		not shown
2822016-2	Nut, #10 HEX	8.2-8	20
2826002-4	Washer, split lock, #4	8.2-7	12
2826035-1	Washer, split lock, #6, used to fasten syringe plunger		not shown
2826045-8	Washer, split lock, #10	8.2-9	10
2826048-2	Washer, split lock, #8	8.2-8	18
2827145-0	Washer, flat, #10	8.2-9	9
2827146-8	Washer, flat, #4, used to fasten optical sensor	8.2-7	12

Table 8.1-5 Miscellaneous Hardware *(Continued)*

Part No.	Description	Figure	Item
2827147-6	Washer, flat, #6, used to fasten syringe plunger		not shown
2827148-4	Washer, flat, #8	8.2-8	17
2851795-5	Screw, captive 6-32 thumbscrew	8.2-2	6
2851835-8	Spacer, #10 St. St. (stainless steel)	8.2-8	21
2851837-4	Spacer, lead screw	8.2-8	12
2851848-0	Nut, 10-32, square	8.2-9	11
2851905-2	Screw, aperture bath mounting thumbscrew	8.2-7	9
2852022-1	Screw, SEMS, pan head Phillips, 4-40 x 1/4 inch	8.2-7	12
2852093-0	Screw, 6-32 x 0.38 in., used to fasten optical sensor bracket	8.2-8 8.2-9	5 7
2852094-8	Screw, SEMS, 6-32 x 0.62 in.	8.2-8	9
6216345-3	Gasket, Hgb LED & Hgb photodiode mounting		not shown
6216357-7	Fitting, sweep-flow		not shown
6805031-6	Bushing, rear aperture module clamp	8.2-7	8
6855211-7	Guide, lead screw guide rod	8.2-8	14

8.2 ILLUSTRATED PARTS

Note: na = part number is not available

Figure 8.2-1 MD II, Lower Chassis, Left Side View (See Table 8.2-1)

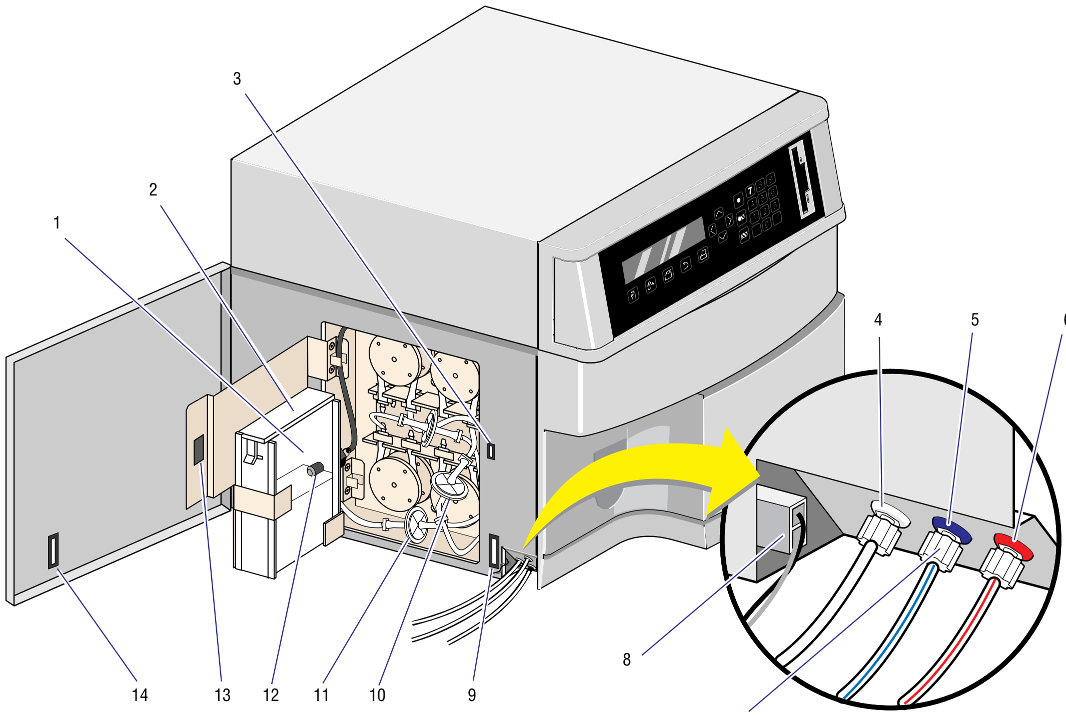


Table 8.2-1 MD II, Lower Chassis, Left Side View (See Figure 8.2-1)

Item	Part Number	Description
1	1017541-1	Reservoir, diluent (uses cover PN 1019609-4)
2	1019609-4	Cover, for diluent reservoir (PN 1017541-1)
3	2840053-5	Magnet, diluent reservoir door, catch
4	6232498-8	Spacer, white plastic indicator for lyse Luer fitting
5	6232499-6	Spacer, blue plastic indicator for diluent Luer fitting
6	6232497-0	Spacer, red plastic indicator for waste Luer fitting
7	6232502-0	Fitting, tubing Luer for reagent connection
8	6028669-8	Cable, waste pickup tube, level sense
9	2840068-3	Magnet, front door and left side, catch
10	6232554-2	Filter, fluid, 10 μ, blue
11	6232076-1	Filter, green fluid barrier
12	6805025-1	Sensor, diluent level sense
13	2840060-8	Plate, reservoir door, magnetic strike
14	2851121-3	Plate, left side and front door, magnetic strike
not shown	6232503-8	Fitting, bulkhead Luer, for reagent connection

Figure 8.2-2 MD II, Front View (See Table 8.2-2)

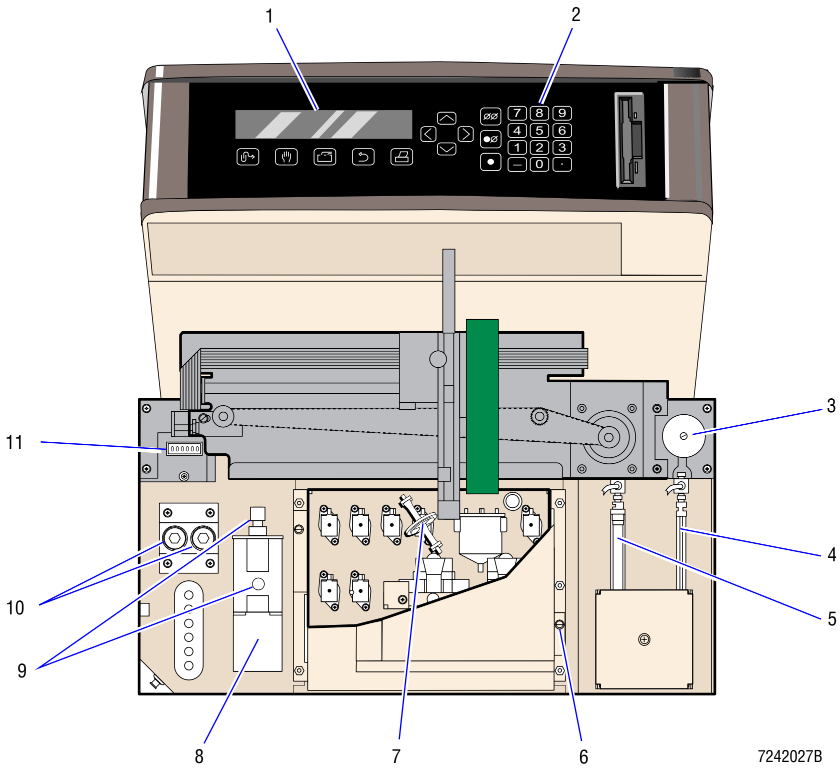


Table 8.2-2 MD II, Front View (See Figure 8.2-2)

Item	Part Number	Description
1	7000168-3	Display, LCD main
2	2016601-1	Keypad, membrane touch pad (use while available)
	2016722-0	Keypad, membrane touch pad, tactile response
3	6232628-0	Regulator, vacuum
4	2523618-1	Syringe, glass, 100 µL 1%, aspirate
5	2523638-6	Syringe, glass, 5.0 mL 1%, diluent
6	2851795-5	Screw, captive 6-32 thumbscrew
7	6232076-1	Filter, green fluid barrier
8	6805022-7	Pump, lyse solenoid
9	6232510-1	Fitting, lyse pump, ferrule and threaded nut
10	6232075-3	Valve, 3-way solenoid, air (LV9 and LV12)
11	2004013-1	Counter, instrument cycle

Figure 8.2-3 MD II, Top View into Lower Chassis (See Table 8.2-3)

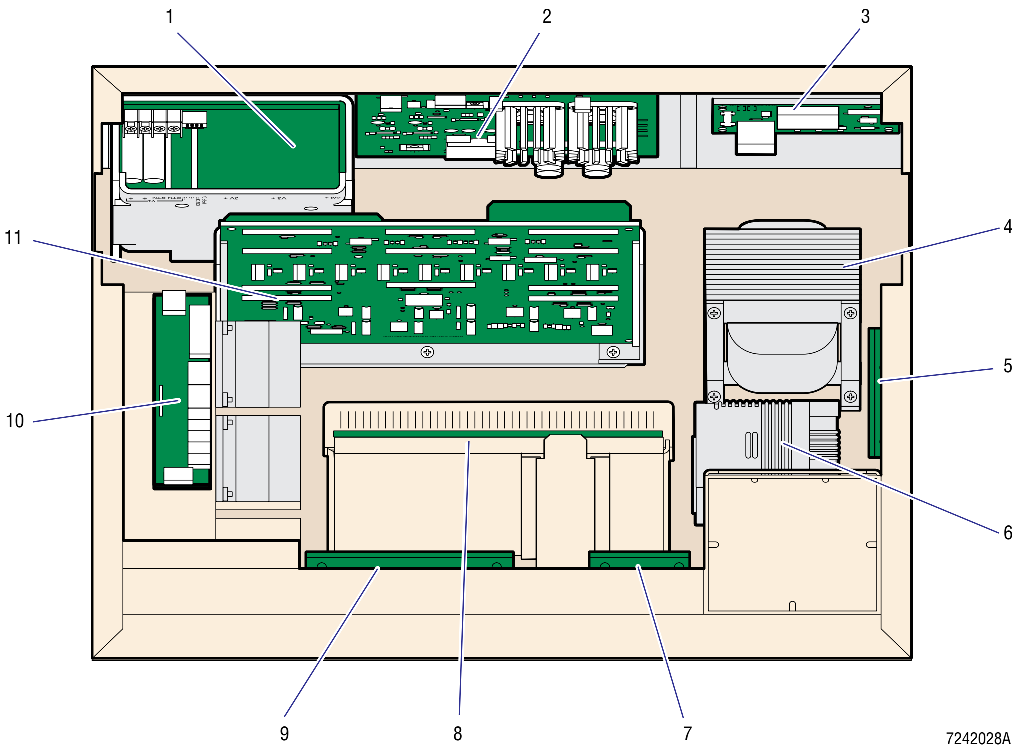


Table 8.2-3 MD II, Top View into Lower Chassis (See Figure 8.2-3)

Item	Part Number	Description
1	4004092-7	Power supply, +24 V switching
2	6706032-6	Card, Linear Power Supply
3	6706065-2	Card, AC Power/Vacuum Relay
4	6859540-1	Transformer, Linear Power Supply card
5	6705721-0	Card, Vacuum Sensor
6	6856899-4	Pump, vacuum, 220 V, 50/60 Hz
	6858007-2	Pump, vacuum, 115 V, 50/60 Hz
7	6706323-6	Card, Hgb Preamp
8	6706150-1	Card, Sensor Preamp Adapter
9	6706202-7	Card, Solenoid Interconnect
10	6706166-7	Card, Flex Connect
11	6706077-6	Card, Motor/Solenoid Driver

Figure 8.2-4 MD II, Upper Chassis (See Table 8.2-4)

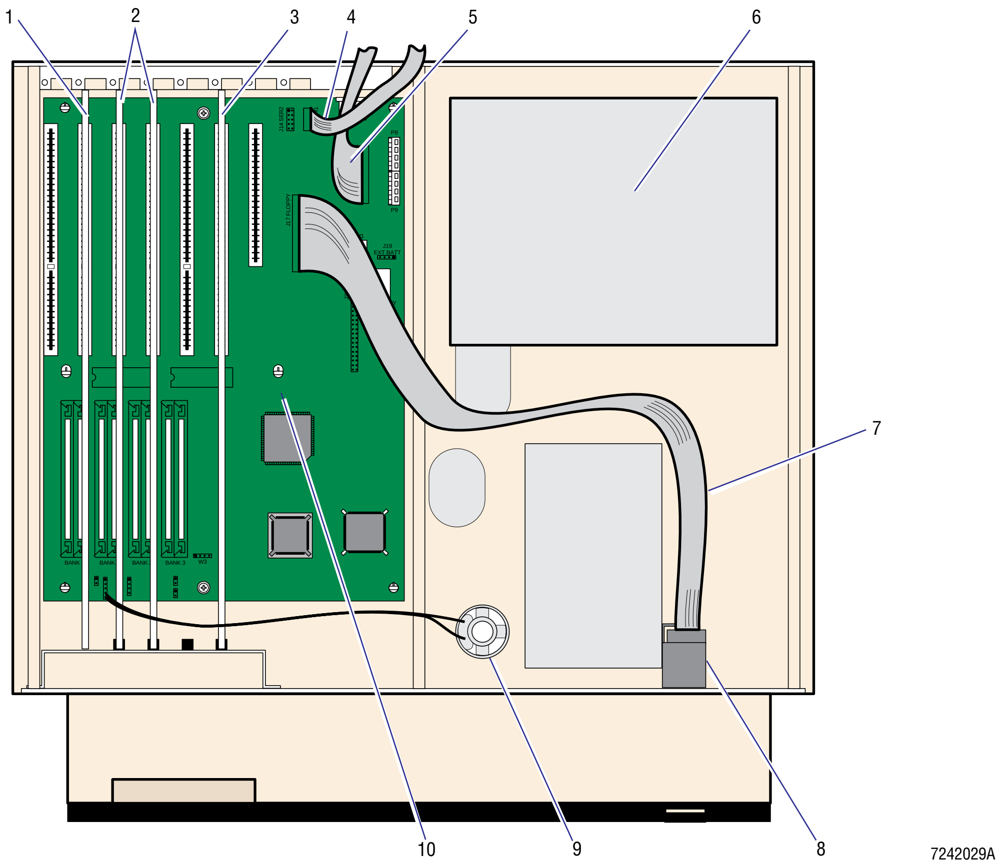


Table 8.2-4 MD II, Upper Chassis (See Figure 8.2-4)

Item	Part Number	Description
1	6706170-5	Card, URA (User Resource Adapter)
2	6706089-0	Cards, DRA (Diluter Resource Adapter)
3	6706165-9	Card, SPAD (Sensor Processing Adapter with Diagnostics)
4	6028518-7	Cable, motherboard/serial 1 connector, ribbon
5	6028522-5	Cable, motherboard/parallel connector, ribbon
6	4004079-0	Power supply, CPU switching
7	na	Cable, ribbon, floppy disk drive to AT motherboard
8	2016503-1	Drive, 3.5 in., 1.44 MB floppy disk
9	6858009-9	Speaker, CPU subassembly
10	7000156-0	CPU, 386 motherboard

Figure 8.2-5 MD II, Back View (See Table 8.2-5)

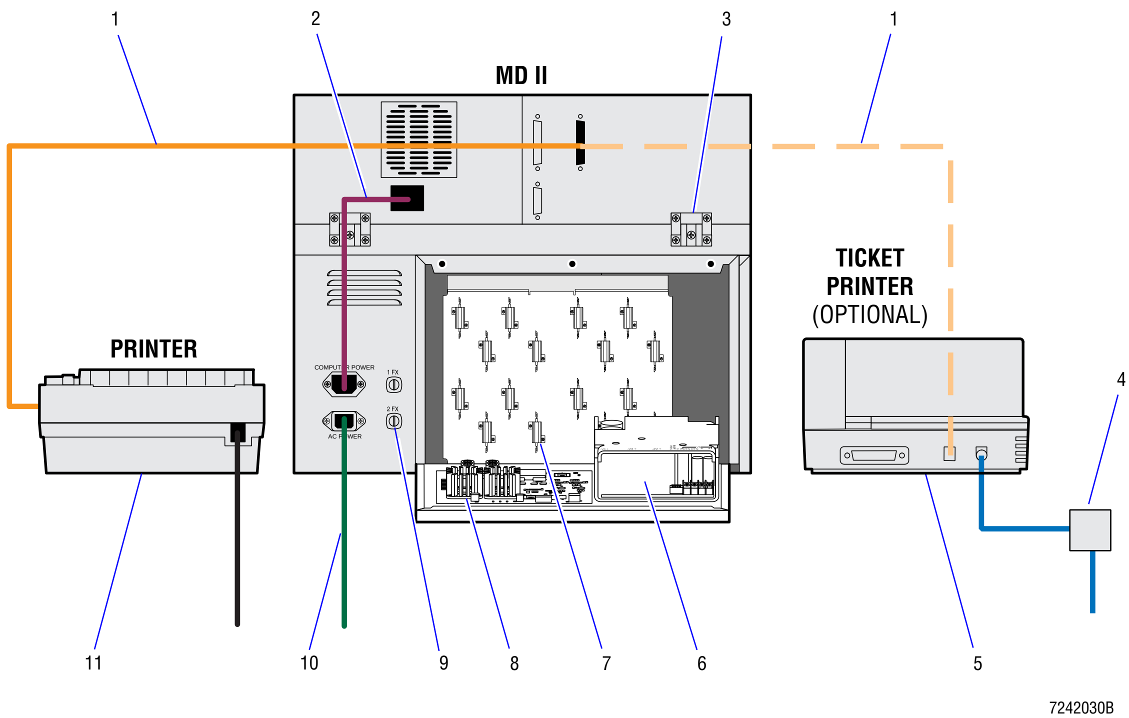


Table 8.2-5 MD II, Back View (See Figure 8.2-5)

Item	Part Number	Description
1	6028504-7	Cable, Centronics parallel Printer, 10 ft
2	6027767-2	Cable, power line cord, ac diluter to analyzer
3	2523685-8	Hinge, upper chassis mounting
4	4004103-6	Power Supply, 24V, for Epson TM290P Printer, Universal
5	2016671-1	Printer, Ticket, 24 V
	4004103-6	Power Supply, Ticket Printer, Universal
	2016577-4	Switch Box, A/B Parallel Switch Box
6	4004092-7	Power supply, +24 V switching
7	4717896-7	Resistor, 25 W, wire-wound, 15 Ω for motor drivers
8	6706032-6	Card, Linear Power Supply
9	5102018-9	Fuse, 4 A, 250 V, (F1 and F2 at back, 120 V instrument)
	5102021-9	Fuse, 2 A, 250 V, (F1 and F2 at back, 220 V instrument)
	9921373-6	Holder, fuse, for F1 and F2 at back
10	6027225-5	Cable, main ac power cable to instrument
11	2016583-9	Printer, CITIZEN GSX-190, parallel, 110 V
	2016584-7	Printer, CITIZEN GSX-190, parallel, 220 V

Figure 8.2-6 Traverse Assembly (See Table 8.2-6)

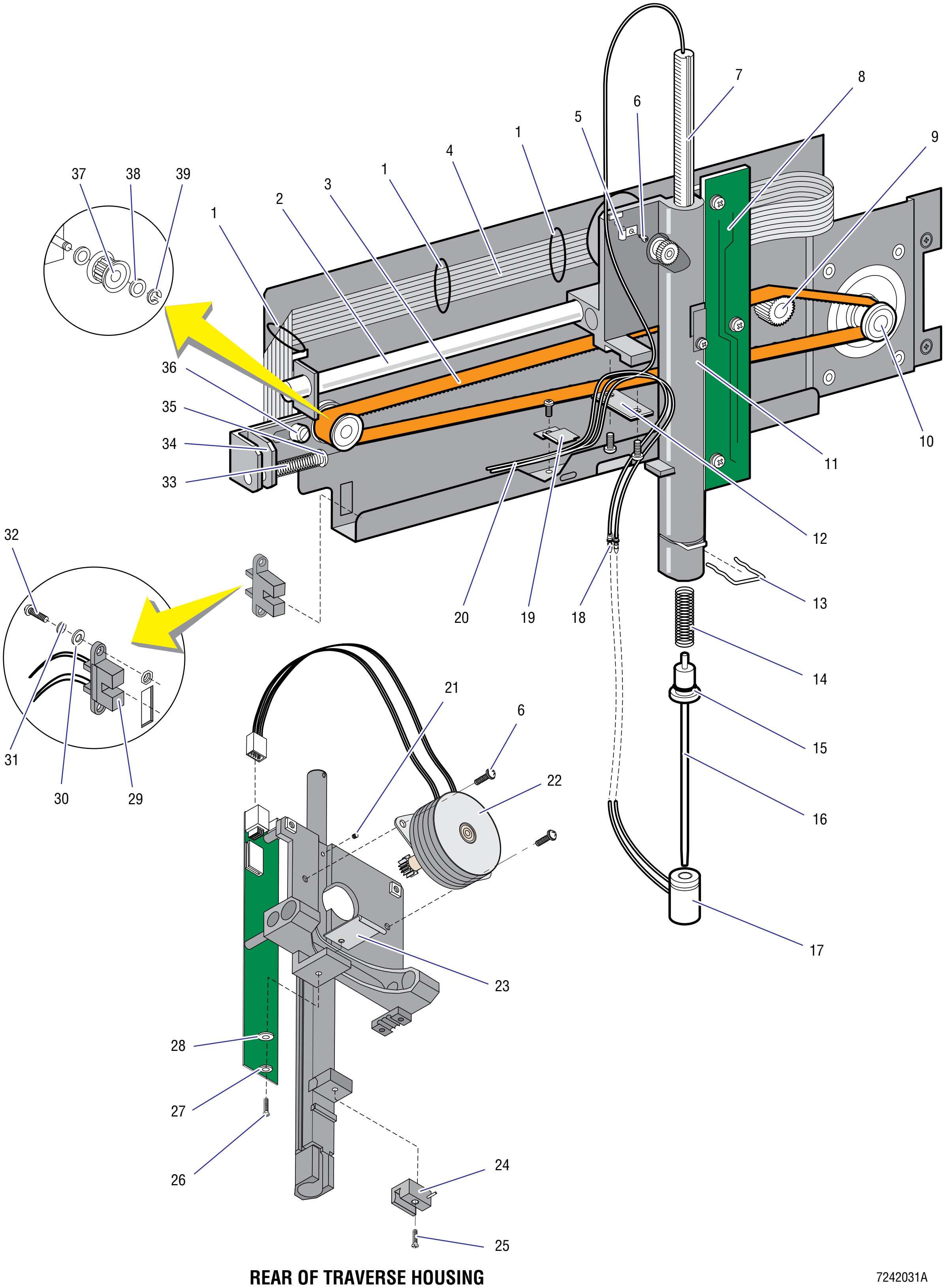


Table 8.2-6 Traverse Assembly (See Figure 8.2-6)

Item	Part Number	Description
1	2512104-0	O-ring, flex cable retainer
2	1022783-6	Shaft, traverse guide
3	2523809-5	Belt, traverse horizontal drive
4	6028597-7	Cable, Probe/Opto Sensor card, Flex Connect card
5	6006044-4	Clamp, aspirate tubing
6	2852218-5	Screw, SEMS, 4-40 x 3/8 in. long
7	1022774-7	Rack, traverse
	6706322-8	Rack and pin.
8	6706161-6	Card, Probe/Opto Sensor
9	6855834-4	Gear, traverse idler pulley
10	2523628-9	Gear, traverse motor
11	6859707-2	Housing, traverse
12	1022860-3	Clamp, clamps 3-tube ribbon to probe housing
13	1022827-1	Clip, wire, used to retain probe wipe housing
14	2523806-1	Spring, probe retainer tension spring
15	2512107-4	O-ring, probe mounting retainer
16	6859741-2	Probe, aspirate assembly
17	6859716-1	Housing, probe wipe, machined
	6805124-0	Housing, probe wipe, molded
18	9908083-3	Fitting, union to probe wipe tubing
19	6859756-1	Clamp, traverse tubing assembly
20	3230005-7	Tubing, 3-piece, probe wipe (34 in. needed)
21	2852245-9	Screw, 6-32 special, slotted pan head
22	6805119-3	Motor, probe, vertical stepper motor assembly
23	6859742-1	Clamp, traverse drive belt clamp assembly
24	na	Guide, traverse housing lower guide (molded)
25	2804038-5	Screw, flat head, 4-40 x 0.5 in.
26	2806090-4	Screw, pan head, 6-32 x 0.5 in.
27	2826035-1	Washer, split lock, #6
28	2827147-6	Washer, flat, #6
29	6805019-7	Switch, traverse opto, horizontal position
30	2851356-9	Washer, flat, #2
31	2826001-6	Washer, split lock, #2
32	2802020-1	Screw, pan head, 2-56 x 0.25 in.
33	2523815-0	Spring, traverse belt tensioner
34	6859738-2	Bracket, traverse tensioner
35	2808072-7	Screw, 8-32 x 1.5 in., traverse belt tensioner
36	2852100-6	Screw, shoulder, tensioner bracket retaining
37	6859786-2	Gear, traverse belt tensioner
38	2827076-3	Washer, #4, traverse tensioner gear spacer
39	2837031-8	Clamp, e-ring, tensioner gear retaining
not shown	6805068-5	Motor, stepper assembly, used throughout instrument

Figure 8.2-7 Diluter Assembly (See Table 8.2-7)

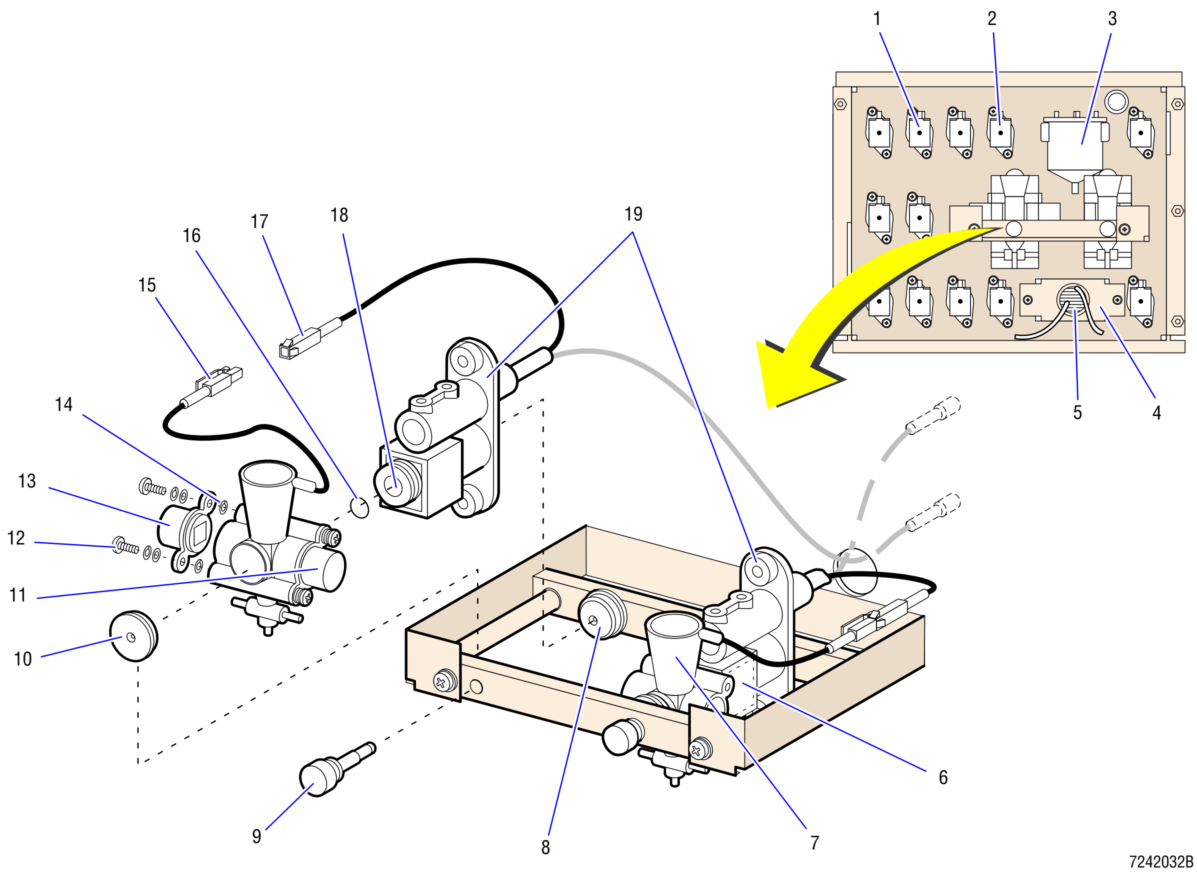


Table 8.2-7 Diluter Assembly (See Figure 8.2-7)

Item	Part Number	Description
1	6232717-1	Valve, Angar 3-way solenoid fluidic
2	6232718-9	Valve, Angar 2-way solenoid fluidic
3	6805080-4	Chamber, vacuum isolator (VIC)
4	1022944-8	Spool, sweep-flow tubing retainer, machined (behind cover plate)
	1022895-6	Spool, sweep-flow tubing retainer, molded (behind cover plate)
5	3202220-1	Tubing, sweep-flow (13 ft needed)
6	6705777-5	Aperture block, RBC
7	6805226-2	Bath, aperture, with external electrode connector, machined
	6232477-5	Fitting, nylon hose, for machined baths
	6805247-5	Bath, aperture, with external electrode connector, molded plasma treated (use when available)
8	6805031-6	Bushing, rear aperture module clamp
9	2851905-2	Screw, aperture bath mounting thumbscrew
10	1022916-2	Bushing, front aperture bath clamp
11	6805033-2	LED, Hgb
12	2852022	Screw, SEMS, pan head Philiips, Screw, 4-40 x 1/4 in.
13	6805010-3	Sensor, Hgb photodetector
14	1022792-5	Washer, rubber
15	2121927-4	Connector, 1-pin plug, mini univ MATE-N-LOK
16	2523657-2	O-ring, aperture/aperture bath seal
17	2121928-2	Connector, 1-pin cable, mini univ MATE-N-LOK
18	6705778-3	Aperture block, WBC
19	na	Housing, rear Aperture Electrode module
not shown	2512120-1	O-ring, small, aperture/aperture module seal
not shown	3814255-1	Filter, Hgb, 525 nm (green) optical filter
not shown	6216357-7	Fitting, sweep-flow

Figure 8.2-8 Syringe Assembly (See Table 8.2-8)

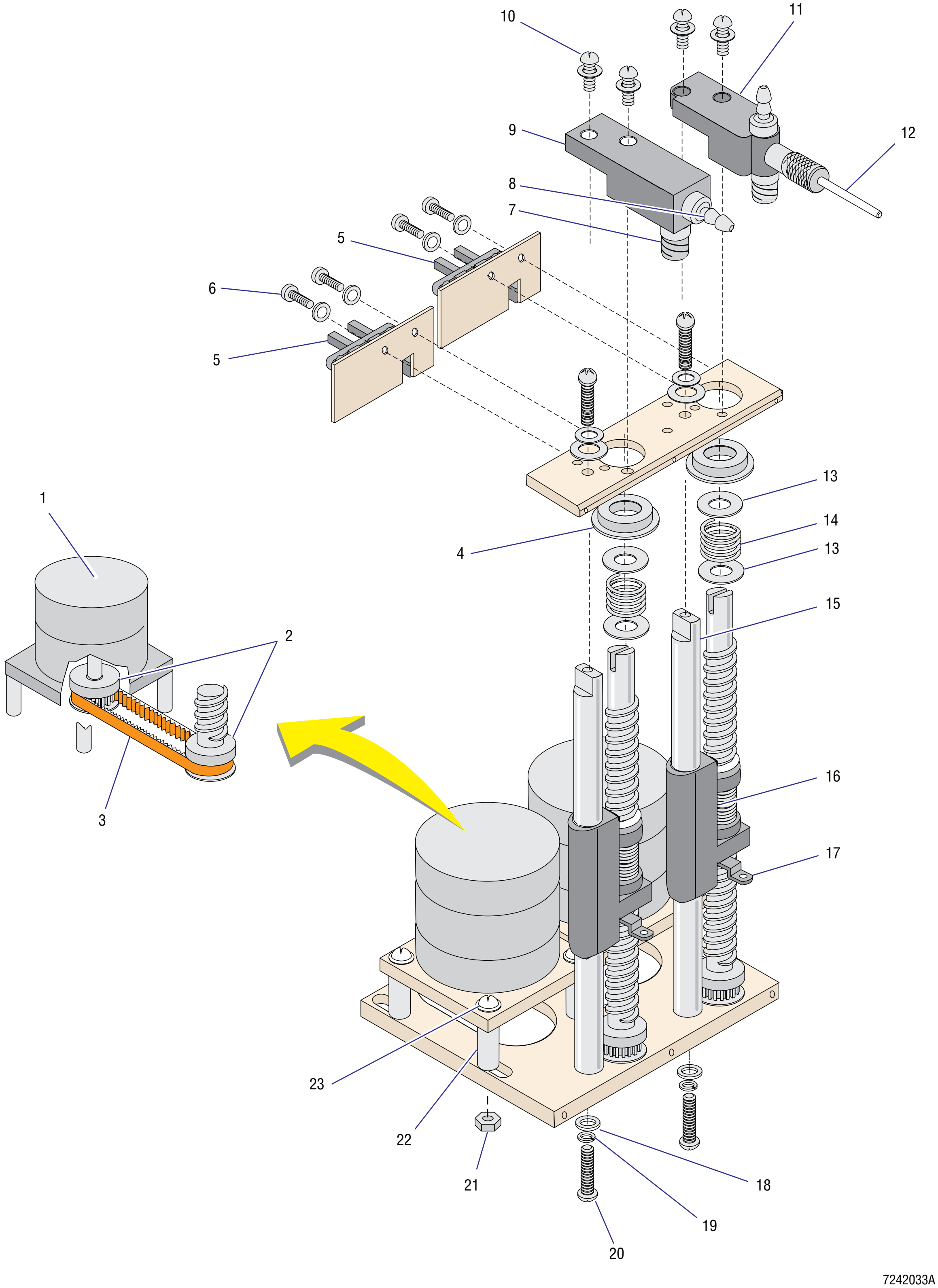


Table 8.2-8 Syringe Assembly (See Figure 8.2-8)

Item	Part Number	Description
1	6805068-5	Motor, stepper assembly
2	2523628-9	Gear, used on lead screw, syringe and traverse motor
3	2523630-1	Belt, syringe lead screw drive
4	2523625-4	Bearing, syringe lead screw (used top and bottom)
5	6805024-3	Sensor, optical assembly used on syringe module
6	2852093-0	Screw, 6-32 x 0.38 in., used to fasten optical sensor bracket
7	6232483-0	Fitting, syringe block Luer for syringe connection
8	1021228-6	Fitting, top of aspirate and diluent syringe block
9	1022814-0	Housing, 2-port manifold for diluent syringe, machined
	1022803-4	Housing, 2-port manifold for diluent syringe, molded (right angle)
10	2852094-8	Screw, SEMS, 6-32 x 0.62 in.
11	1020601-4	Housing, 3-port manifold for aspirate syringe, molded
12	6232463-5	Fitting, aspirate fitting, front of syringe mount
13	2851837-4	Spacer, lead screw
14	2523644-1	Spring, lead screw tension
15	6855211-7	Guide, lead screw guide rod
16	2523793-5	Screw, syringe lead screw and housing assembly
17	1020507-7	Bracket, syringe mounting
18	2827148-4	Washer, flat, #8
19	2826048-2	Washer, split lock, #8
20	2808069-7	Screw, pan head, 8-32 x 0.56 in.
21	2822016-2	Nut, #10 HEX
22	2851835-8	Spacer, #10 St. St. (stainless steel)
23	2810047-7	Screw, 10-32 x 1.5 in. pan head Phillips
not shown	2826045-8	Washer, split lock, #10
not shown	2826035-1	Washer, split lock #6, used to fasten syringe plunger
not shown	2827147-6	Washer, flat, #6, used to fasten syringe plunger
not shown	2806125-1	Screw, 6-32 x 0.38 in. HEX head, used to fasten syringe plunger
not shown	2827146-8	Washer, flat, #4, used to fasten optical sensor
not shown	2826002-4	Washer, split lock, #4, used to fasten optical sensor
not shown	2822003-1	Nut, HEX, 4-40, used to fasten optical sensor

Figure 8.2-9 Peristaltic Pump Assembly (See Table 8.2-9)

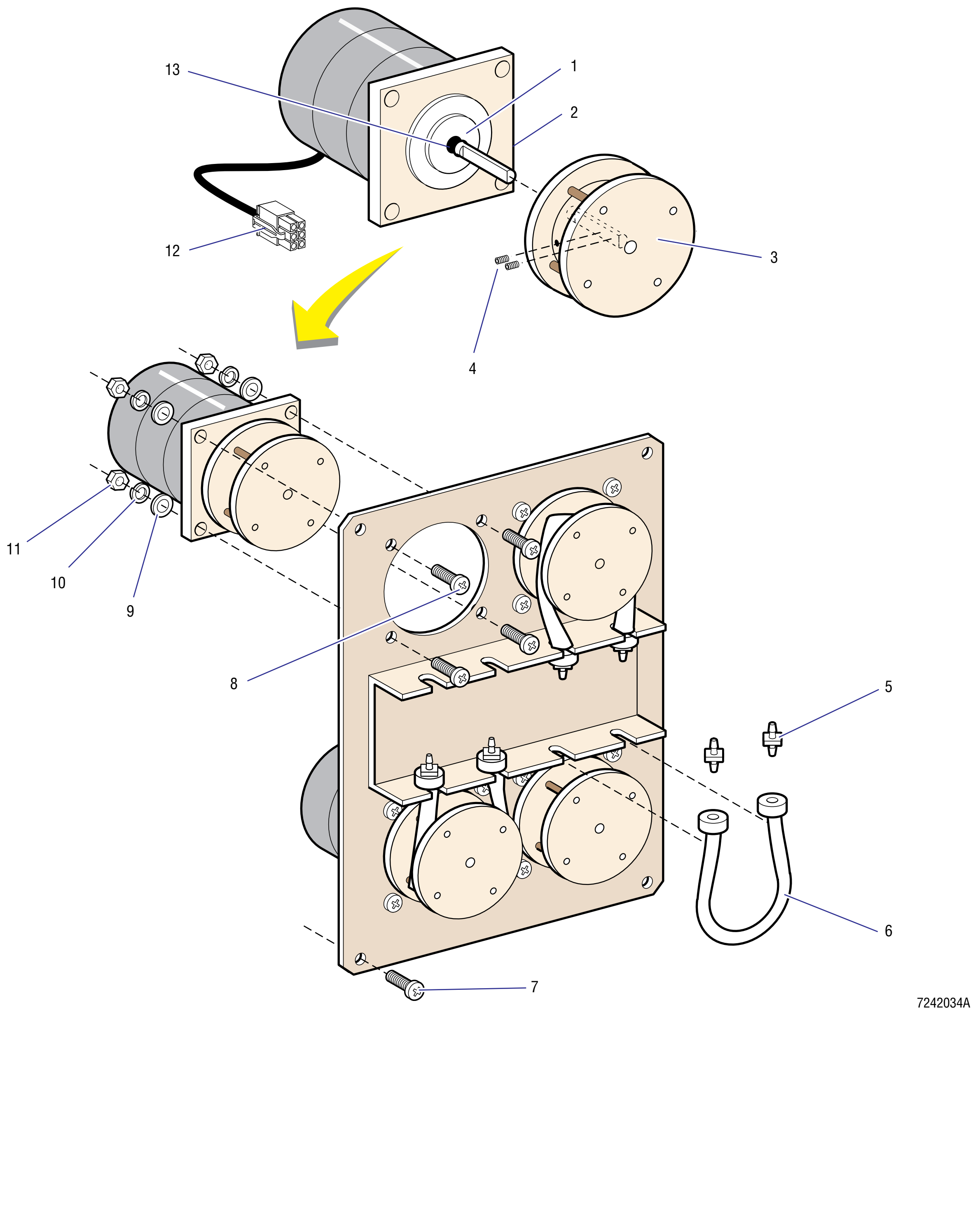


Table 8.2-9 Peristaltic Pump Assembly (See Figure 8.2-9)

Item	Part Number	Description
1	1014052-8	Washer, stepper motor wear plate
2	6805068-5	Motor, stepper assembly
3	6859650-5	Spool, peristaltic pump tubing
4	2827024-1	Screw, 6-32 HEX head setscrew, peristaltic spool
5	6232246-2	Fitting, plastic reducer, peristaltic pump tubing
6	3213214-6	Tubing, silicon, peristaltic pump
7	2852093-0	Screw, machine, 6-32 x 0.38 in.
8	2810026-4	Screw, machine, 10-32 x 0.62 in.
9	2827145-0	Washer, flat, #10
10	2826045-8	Washer, split-lock, #10
11	2851848-0	Nut, 10-32, square
12	2121691-7	Connector, 6-pin plug, mini univ MATE-N-LOK
13	2523083-3	Seal, rubber ring seal for stepper motor
not shown	1601065-1	Adhesive, LOCTITE 222, THREADLOCKE2
not shown	1604007-0	Lubricant, DOW CORNING 33
not shown	2121719-1	Contact, socket, mini univ MATE-N-LOK, 26-22 AWG

A QUICK REFERENCE INFORMATION, A.1-1

A.1 TOLERANCES, VOLTAGES AND LIMITS, A.1-1
Limits, A.1-1
Adjustments, A.1-1

A.2 SWITCH SETTINGS, JUMPER SETTINGS AND TEST POINTS, A.2-1
AC Power/Vacuum Relay Card, A.2-1
Connectors, A.2-1
Test Points, A.2-1
AT Motherboard, A.2-1
DRA Card, A.2-2
Hgb Preamp Card, A.2-2
Test Points, A.2-2
Linear Power Supply Card, A.2-2
Jumpers, A.2-2
Test Points, A.2-2
Motor/Solenoid Driver Card, A.2-3
Jumpers, A.2-3
Test Points, A.2-3
Sensor Preamp Adapter Card, A.2-4
SPAD Card, A.2-4
URA Card, A.2-4
Vacuum Sensor Card, A.2-4

A.3 PRINTER SETTINGS, A.3-1

A.4 FUNCTIONS, A.4-1
Peristaltic Pumps, A.4-1

A.5 MENU TREE, A.5-1

B PROCEDURES FOR SPECIAL TOOLS OR SOFTWARE, B.1-1

B.1 PROCEDURES FOR SPECIAL TOOLS OR SOFTWARE, B.1-1

C MESSAGE/ERROR CODE LISTINGS, C.1-1

C.1 INSTRUMENT NON-FATAL ERROR MESSAGES, C.1-1

C.2 INSTRUMENT FATAL ERROR MESSAGES, C.2-1

C.3 AMIBIOS BEEP CODES, C.3-1

D OPTIONAL PRINTERS, D.1-1

D.1 EPSON TM-290P SLIP PRINTER, D.1-1
Specifications, D.1-1
Operator Controls and LEDs, D.1-1
DIP Switch SW1 Settings, D.1-2
Installation Procedure, D.1-2
Printer Self-Test, D.1-2

E INTELLIGENT SOFTWARE LINK (ISL) OPTION, E.1-1

E.1 ISL OPTION FOR RALS, E.1-1
ISL Description, E.1-1
RALS Installation, Training and Service Responsibilities, E.1-1
Recognizing an MD II Linked to RALS, E.1-1
Servicing an MD II Linked to RALS, E.1-1

ILLUSTRATIONS

A.3-1 CITIZEN GSX-190 Printer Settings, A.3-1

A.5-1 Software Menu Tree, A.5-1

D.1-1 Epson TM-290P Slip Printer Control Locations, D.1-1

TABLES

A.1-1 Calibration Factor Limits, A.1-1
A.1-2 Amplifier Noise Limits, A.1-1
A.1-3 Adjustments, A.1-1

A.2-1 AC Power/Vacuum Relay Card Connectors and Line Input Ranges, A.2-1
A.2-2 AT Motherboard Switch and Jumper Settings, A.2-1
A.2-3 DRA Card Jumper Settings, A.2-2
A.2-4 Linear Power Supply Card Jumper Settings, A.2-2
A.2-5 Linear Power Supply Card Test Points, A.2-2
A.2-6 Motor/Solenoid Driver Card Jumper Settings, A.2-3
A.2-7 Motor/Solenoid Driver Card Test Points, A.2-3
A.2-8 Sensor Preamp Adapter Card Jumper Settings, A.2-4
A.2-9 URA Card Switch and Jumper Settings, A.2-4
A.2-10 Vacuum Sensor Card Test Points, A.2-4

A.4-1 Peristaltic Pumps Location and Function, A.4-1

C.1-1 Non-fatal Error Messages, C.1-1

C.2-1 Fatal Error Messages, C.2-1

C.3-1 AT Motherboard AMIBIOS Beep Codes, C.3-1

D.1-1 DIP Switch SW1 Position Settings, D.1-2
D.1-2 DIP Switch SW1 Settings for International Character Sets, D.1-2

A.1 TOLERANCES, VOLTAGES AND LIMITS

Limits

Table A.1-1 Calibration Factor Limits

Parameter	Expected Range
WBC	0.975 to 1.169
RBC	1.079 to 1.251
Hgb	0.774 to 0.898
MCV	0.897 to 0.949
Plt	1.004 to 1.214
MPV	1.074 to 1.278

ATTENTION: Millivolts (mV) must be measured with a true rms (root mean square) DMM (digital multi-meter). The FLUKE® Model 8920A or its equivalent is acceptable.

Table A.1-2 Amplifier Noise Limits

Parameter	Test Points	Expected Range
WBC	TP2, TP15 (ground)	50 to 90 mVrms
RBC	TP3, TP15 (ground)	8 to 15 mVrms
Plt	TP1, TP15 (ground)	40 to 80 mVrms

Adjustments

Table A.1-3 Adjustments

Item	Adjustments
+24 V Power Supply	V1 - This is set at the factory. It **cannot** and **must not** be adjusted in the field.
Hgb Preamp Card	• R7 - Hgb preamp gain adjustment (adjusts output voltage) • R8 - Preamp offset adjustment (adjusts Hgb zero)
SPAD Card	There are two potentiometers onboard, R85 and R86. These are factory adjustments affecting the Editor circuit that require an oscilloscope and pulse generator to set them. They **cannot** and **must not** be adjusted in the field.
URA Card	• R5 - Display contrast • R6 - A/D converter zero adjustment • R7 - A/D converter scale adjustment
Vacuum Sensor Card	R2 - The Gain adjustment calibrates the card and requires an accurate vacuum measuring device to set it. It is a factory adjustment and **cannot** and **must not** be adjusted in the field.

A.2 SWITCH SETTINGS, JUMPER SETTINGS AND TEST POINTS

AC Power/Vacuum Relay Card

Connectors

Table A.2-1 AC Power/Vacuum Relay Card Connectors and Line Input Ranges

Connector	Range
100 VOLTS	90 - 110 Vac
120 VOLTS	110 - 132 Vac
220 VOLTS	198 - 242 Vac
240 VOLTS	220 - 264 Vac

Test Points

TP1, TP2-ac in

AT Motherboard

Table A.2-2 AT Motherboard Switch and Jumper Settings

Switch or Jumper	Description	MD II Setting
SW1-1	ON - Uses onboard battery OFF - Uses off-board battery	ON
SW1-2	ON - Enables battery OFF - Disables battery	ON
SW1-3	ON - Additional wait states for IDE interface OFF - No additional wait states	OFF
SW1-4	ON - For color adapter OFF - For monochrome adapter (does not matter when using EGA/VGA)	OFF
W3 (Jumper)	1 to 2, 3 to 4 - 25K or 1 MB 2 to 3 - 4 MB	1 to 2, 3 to 4

DRA Card

Table A.2-3 DRA Card Jumper Settings

Jumper	Description	MD II Setting
X4	Sets card for IRQ11, needed for DRA1 Sets card for IRQ12, needed for DRA2	1-3 2-3
X5	Sets card to DRA1 or DRA2	ON - DRA1 OFF - DRA2
X6	Connects oscillator to circuit when jumped	ON

Hgb Preamp Card

Test Points

TP1 - orange, output
TP2 - black, ground

Linear Power Supply Card

Jumpers

Table A.2-4 Linear Power Supply Card Jumper Settings

Jumper	Description	MD II Setting
X1	Used to provide grounding for testing the card outside the unit.	OFF
X2	Used to provide grounding for testing the card outside the unit.	OFF
X3	Used to provide grounding for testing the card outside the unit.	OFF

Test Points

Table A.2-5 Linear Power Supply Card Test Points

Test Point	Supply
TP1	+240 Vdc ground
TP2	+240 Vdc
TP3	-15 Vdc ground
TP4	-15 Vdc
TP5	+15 Vdc ground
TP6	+15 Vdc
TP7	Hgb LED cathode (negative lead)
TP8	Hgb LED anode (positive lead)
TP9	RBC aperture voltage
TP10	WBC aperture voltage
TP11	Aperture zap voltage (200 V)

Motor/Solenoid Driver Card

Jumpers

Table A.2-6 Motor/Solenoid Driver Card Jumper Settings

Jumper	Description	MD II Setting
X1	+24 V control	ON
X2	ON - Connects oscillator to circuit OFF - Disconnects oscillator for card testing	ON

Test Points

Table A.2-7 Motor/Solenoid Driver Card Test Points

Test Point	Supply
TP1	Overload Timer input to comparator
TP2	Overload Timer output
TP3	Common ground
TP4	Lyse sensor output
TP5	Overload timer reference (16 V)
TP6	+24 V supply
TP7	Waste level output
TP8	Probe-wipe down sensor output
TP9	Probe-wipe upper sensor output
TP10	Diluent sensor output
TP11	Spare sensor output
TP12	Probe WBC position sensor output
TP13	Probe aspirate position sensor output
TP14	Probe RBC position sensor output
TP15	Aspirate syringe sensor output
TP16	Diluent syringe sensor output
TP17	POWER ON signal (to +24 V supply)
TP18	Overload Timer +24 V input supply
TP19	Spare sensor output
TP20	Spare sensor output
TP21	Spare sensor output
TP22	Spare sensor output
TP23	Oscillator output

Sensor Preamp Adapter Card

Table A.2-8 Sensor Preamp Adapter Card Jumper Settings

Jumper	Description	MD II Setting
X3	Grounds WBC Dc Restorer input for subassembly adjustment and testing.	OFF
X4	Connects WBC Preamp output to Dc Restorer.	ON
X7	Connects RBC Preamp output to Dc Restorer.	ON
X8	Grounds RBC Dc Restorer input for subassembly adjustment and testing.	OFF

SPAD Card

X7 (ON)

- ON connects oscillator to circuit
- OFF disconnetcs oscillator for card testing

URA Card

Table A.2-9 URA Card Switch and Jumper Settings

Switch or Jumper	Description	MD II Setting
SW1-1	OFF - MICRO-PAK reagent ON - Bulk reagent	OFF
SW1-2	OFF - Does not create INF file ON - Creates INF file	OFF
SW1-3	OFF - Normal operation ON - Final test functions	OFF
SW1-4	OFF - Normal operation ON - Adds Service Report when SW1-3 is ON	OFF
SW1-5 to SW1-8	Not used	OFF
X1	Connects oscillator to circuitry	ON

Vacuum Sensor Card

Table A.2-10 Vacuum Sensor Card Test Points

Test Point	Description
TP1	8.006 V reference voltage (7.964 V to 8.049 V)
TP2	Transducer output
TP3	Gain adjustment output
TP4	Ground
TP5	VAC OUT

A.3 PRINTER SETTINGS

Figure A.3-1 shows the MD II settings for the CITIZEN GSX-190 Printer. If that is the Printer at this site, use these settings.

Figure A.3-1 CITIZEN GSX-190 Printer Settings

CITIZEN GSX-190

Default Setting Report

Default settings are **EMPHASIZED.**

INSTALL 1							
RIBBON	**NORMAL**	COLOR					
A.S.F.	**OFF**	ASF+ENV	ASF				
EMULATION	EPSON	**IBM**					
PRINT STYLE							
FONT	**DRAFT**	HS-DRAFT	ROMAN	SANS SER	COURIER	PRESTIGE	SCRIPT
	ORATOR						
EMPHASIZED	**OFF**	ON					
PITCH	**10 CPI**	12 CPI	15 CPI	PROPORTIONAL			
FONT LOCK	**OFF**	ON					
PAGE LAYOUT							
LINE SPACING	**6 LPI**	8 LPI					
FORM LENGTH	5 INCH	7 INCH	**LETTER**	A4	12 INCH	LEGAL	
PRINT MODE							
NLQ DIR	BI-DIR	**UNI-DIR**					
GRAPHIC DIR	BI-DIR	**UNI-DIR**					
CHARACTER							
SLASH ZERO	**OFF**	ON					
CHARACTER SET	**SET 1**	SET 2					
CODE PAGE	**U.S.A.**	MULTI	PORTUGAL	CANADA	NORWAY	SCANDNVA	TURKEY
	ICELAND	WINDOWS					
INSTALL 2							
TEAR OFF	OFF	**ON**					
PAPER OUT	**ENABLE**	DISABLE					
AUTO CR	**OFF**	ON					
AUTO LF	**OFF**	ON					
COPY MODE	**OFF**	ON					
ENVELOPE	**OFF**	ON					

7242050A

A.4 FUNCTIONS

Peristaltic Pumps

Table A.4-1 Peristaltic Pumps Location and Function

Pump	Location	Function
PM1 (Air/Mix)	Upper right	Provides air for isolation and mixing bubbles.
PM2 (Diluent)	Upper left	Fills the diluent reservoir from the diluent tube.
PM3 (Rinse)	Lower left	Rinses the baths with fluid from the diluent reservoir.
PM4 (Waste)	Lower right	Drains the VIC and both red and white baths.

A.5 MENU TREE

Figure A.5-1 Software Menu Tree

- 1. RUN SAMPLE → [PASSWORD] → [ENTER ID / ENTER RANGE] → *ASPIRATE*
- 2. RUN CONTROL → [CONTROL LEVEL OPTIONS: 1. LOW, 2. NORMAL, 3. HIGH] → *RUN CONTROL*
- 3. STARTUP
- 4. REVIEW LAST SAMPLE
- 5. SPECIAL FUNCTIONS
  - 1. SETUP
    - 1. DATE/TIME
      - 1. SELECT DATE FORMAT
      - 2. CHANGE DATE AND TIME
    - 2. IQAP ID #
    - 3. HOST SETTINGS
      - 1. HOST COMMUNICATION
      - 2. BAUD RATE
      - 3. DATA BITS
      - 4. PARITY
      - 5. STOP BITS
    - 4. OPTIONS
      - 1. PRINT
        - 1. AUTOMATIC
        - 2. MANUAL
      - 2. CONTROL
        - 1. COULTER CONTROL/AUTOMATED DISK
        - 2. OTHER CONTROLS/MANUAL
      - 3. CALIBRATION
        - 1. COULTER CALIBRATOR/AUTOMATED DISK
        - 2. OTHER CALIBRATOR/MANUAL
      - 4. REPORT FORMAT
        - 1. FULL PAGE REPORT
        - 2. SPLIT PAGE REPORT
        - 3. TICKET REPORT
      - 5. REPORT SECTIONS
        - 1. MICROSCOPIC
        - 2. PATIENT DEMOGRAPHICS
        - 3. TICKET OPTIONS
          - 1. PARAMETER UNITS
          - 2. PARAMETER RANGES
          - 3. PARAMETER LABELS
        - 4. HISTOGRAMS
      - 6. AUTO SEQUENCE
        - 1. AUTO SEQUENCE ON
        - 2. AUTO SEQUENCE OFF
    - 5. UNITS
      - 1. STANDARD FORMATS
      - 2. CUSTOM FORMATS
    - 6. INSTITUTION NAME
  - 2. REAGENT LOT #
  - 3. DILUTER FUNCTIONS
    - 1. CLEAR APERTURES
    - 2. DISPENSE LYSE
    - 3. DRAIN
    - 4. RINSE
    - 5. MIX
    - 6. CLEAN BATHS
  - 4. SUPERVISOR
    - 1. QA FUNCTIONS
      - 1. PRINT QA
        - 1. PRINT SUMMARY
        - 2. PRINT GRAPHS
        - 3. PRINT ASSAY SHEET
        - 4. PRINT ALL QC
      - 2. PREPARE IQAP
      - 3. MEAN TO ASSAY
      - 4. RESTORE DEFAULTS
      - 5. CHANGE ASSAY VALUES
      - 6. CHANGE QC RANGES
    - 2. RANGES
      - 1. PRINT RANGES
        - [1. RANGE 1 / 2. RANGE 2 / 3. RANGE 3]
          - 1. CBC-A
          - 2. CBC-B
          - 3. DIFF
          - 4. ALL
      - 2. CHANGE RANGES
      - 3. SELECT RANGE FILE(S)
    - 3. PASSWORD ACCESS
    - 4. AUTO CALIBRATION
      - 1. REPRODUCIBILITY AND CARRYOVER
      - 2. CALIBRATION
      - 3. PRINT CALIBRATION ASSAY SHEET
    - 5. PRINT CAL FACTORS
    - 6. CHANGE CAL FACTORS
    - **7. [NO ITEM] → SERVICE REPORT**
  - 5. SERVICE
    - 1. LATEX GAIN (FOR COULTER SERVICE ONLY)
    - 2. REPLACE SYRINGE (FOR COULTER SERVICE ONLY)
    - 3. PULSE TEST
    - 4. VOLTAGE READINGS
    - 5. VACUUM ADJUST
    - 6. REVISION LEVELS
    - **7. [NO ITEM] → [PASSWORD] → SERVICE DIAGNOSTIC**
- 6. SHUTDOWN → *PRESENT CONCENTRATED CLEANER TO THE PROBE*
- **7. [NO ITEM] → REBOOTS SYSTEM**

7242002B

B.1 PROCEDURES FOR SPECIAL TOOLS OR SOFTWARE

A Service Diagnostic disk will eventually be available for this product. When it becomes available, this section will contain instructions on its use.

C.1 INSTRUMENT NON-FATAL ERROR MESSAGES

Table C.1-1 Non-fatal Error Messages

Displayed Message	Description
Hgb Blank Voltage High	An Hgb-blank reading was greater than 4.95 V.
Hgb Blank Voltage Low	An Hgb-blank reading was less than 2.50 V.
Unable to Create INF File	The system attempted to create an INF file but was unable to do so.
Vacuum out of Range	The vacuum for one of the 12, one-second count periods was outside 5.83 to 6.17 in. Hg.

C.2 INSTRUMENT FATAL ERROR MESSAGES

Table C.2-1 Fatal Error Messages

Error Code	Displayed Message	Description
001	*SPAD Board Failure*	Currently not used.
002	*URA Board Failure*	Currently not used.
003	*DRA Board Failure*	A motor driver did not generate an interrupt to indicate that it finished an operation.
004	*SPAD Board Failure*	While channelizing pulses, a buffer overload occurred.
005	*System Disk File Corrupt*	The system was unable to load a resource file from the Program Disk.
006	*Insufficient RAM*	The system attempted to allocate memory to perform a function and there was insufficient memory available.
008	*URA Board Failure*	The analog multiplexer on the URA card failed.
009	*URA Board Failure*	There was a timeout while the URA card was performing an A/D conversion.
010	*Keypad Failure*	Currently not used.
011	*URA CMOS Failure*	There is a problem with the data stored in the URA CMOS.
012	*System Disk File Corrupt*	The system could not load an acceptable PD.DAT file from the Program Disk.
013	*CPU Fatal Error*	The CPU signaled the system software of a problem. This generally means it tried to execute an illegal instruction.
014	*Power Supply Failure*	There was a failure from a voltage check of the +15, +5, +12 and supplies.
015	*Power Supply Failure*	There was a failure when checking the +24 V power supply.
016	*System Disk File Corrupt*	The system was unable to load a good printer report template file from the Program Disk.
017	*Unable to Sense Diluent Level*	During self-test, the system was unable to force a state change of the diluent sensor.
018	*Copy Protection Violation*	The instrument detected wrong resource files on the Program Disk.
019	*System Disk File Corrupt*	The instrument detected a failure of the CRC check while loading a file from disk. This failure indicates that the system disk file is corrupt.
020	*Count Period Timeout*	During one of the 12 count periods, the system was channelizing data for longer than one second.
021	*Software Timer Error*	The software was unable to allocate a software timer.
026	*Aspirate Syringe Failure*	The aspirate syringe was not sensed at the home sensor when it should have been.
027	*Aspirate Syringe Failure*	The aspirate syringe was sensed at the home sensor when it should not have been.
028	*Diluent Syringe Failure*	The diluent syringe was not sensed at the home sensor when it should have been.
029	*Diluent Syringe Failure*	The diluent syringe was sensed at the home sensor when it should not have been.
030	*Probe Mechanism Failure*	The probe was not at the top position when it should have been.

Table C.2-1 Fatal Error Messages *(Continued)*

Error Code	Displayed Message	Description
031	*Probe Mechanism Failure*	The probe was at the top position when it should not have been.
032	*Probe Mechanism Failure*	The probe was not above the WBC bath when it should have been.
033	*Probe Mechanism Failure*	The probe was not above the RBC bath when it should have been.
034	*Probe Mechanism Failure*	The probe was not at the aspirate station when it should have been.
037	*Software Fatal Error*	During the execution of the system software, a software error occurred.
038	*RAM Drive Failure*	The system was unable to create a Virtual RAM drive.
039	*SPAD Board Failure*	A/D conversion timeout for a SPAD A/D operation.

C.3 AMIBIOS BEEP CODES

Beep codes (Table C.3-1) are errors found during the first stage of the Power On Self Test (POST). All beep code errors except beep code 8 are fatal errors. A fatal error does not allow the boot process to continue.

Errors occurring after this phase are non fatal and are displayed to a computer monitor. The MD II's display is not a computer monitor and is driven by the system software and hardware. Since the software is loaded after the boot process is complete, the instrument cannot display these non-fatal error messages.

Table C.3-1 AT Motherboard AMIBIOS Beep Codes

Beeps	Error Message	Description
1	*Refresh Failure*	The Memory Refresh circuitry on the motherboard is faulty.
2	*Parity Error*	The system detected a parity error in base memory.
3	*Base 64 KB Memory Failure*	The system detected a memory failure in the first 64 KB of memory.
4	*Timer Not Operational*	The system detected a memory failure in base memory or Timer 1 on the motherboard is not functioning.
5	*Processor Error*	The CPU on the motherboard generated an error.
6	*8042 - Gate A20 Failure*	The CPU is unable to switch to protected mode. Gate A20 on the keyboard controller (8042) allows the CPU to operate in protected mode.
7	*Processor Exception Interrupt Error*	The CPU generated an exception interrupt.
8	*Display Memory Read/Write Error*	The system video adapter is either missing or its memory is faulty. This is not a fatal error.
9	*ROM Checksum Error*	The ROM checksum value does not match the value in BIOS.
10	*CMOS Shutdown Register Read/Write Error*	The shutdown register for CMOS RAM has failed.

D.1 EPSON TM-290P SLIP PRINTER

Specifications

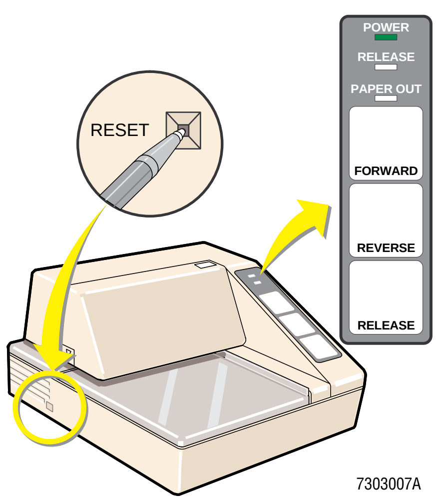
Print method:	Impact dot matrix Shuttle-type, 7 pin head Unidirectional printing We use a 0.63 mm column spacing We use 4.23 mm (1/6 in.) line spacing
Ribbon:	Exclusive ribbon cassette Type ERC-27 Purple ink Life expectancy about 1,500,000 characters
Paper:	Types - Normal (High Quality), pressure sensitive, carbon copy Total thickness for single-ply paper (no copy) - 0.09 to 0.25 mm (135 kg paper) Total thickness with copy paper - 0.09 to 0.35 mm Maximum copies, 1 original and 2 copies
Interface:	Coulter uses the parallel interface (Centronics compatible)

Operator Controls and LEDs

See Figure D.1-1 for location of operator controls.

RELEASE key:	Releases the paper
REVERSE key:	Feeds the paper backward
FORWARD key:	Feeds the paper forward
POWER LED:	Green - lights when power is on
PAPER OUT LED:	Red - lights when paper is out
RELEASE LED:	Green - lights when Printer is in the release state Green - blinks when Printer is in an error state

Figure D.1-1 Epson TM-290P Slip Printer Control Locations



DIP Switch SW1 Settings

Table D.1-1 DIP Switch SW1 Position Settings

Positions/Settings									
1 - OFF	**2 - ON**	**3 - ON**	**4 - ON**	**5 - OFF**	**6 - OFF**	**7 - OFF**	**8 - OFF**	**9 - OFF**	**10 - OFF**
ON = Autofeed	International Character Sets - See Table D.1-2			Not Used	Not Used	Not Used	Not Used	Not Used	Not Used

Table D.1-2 DIP Switch SW1 Settings for International Character Sets

	Position Settings		
Country	**SW1- 2**	**SW1- 3**	**SW1- 4**
U.S.A.	ON	ON	ON
France	OFF	ON	ON
Germany	ON	OFF	ON
U.K.	OFF	OFF	ON
Denmark	ON	ON	OFF
Sweden	OFF	ON	OFF
Italy	ON	OFF	OFF
Spain	OFF	OFF	OFF

Installation Procedure

See Epson TM-290P Slip Printer under Heading 3.4, OPTIONAL TICKET PRINTERS.

Printer Self-Test

1. Ensure the MD II power is on and the Printer power line cord is plugged in.
2. Press the RELEASE key on the Printer.
3. Insert a ticket in the Printer.
4. Unplug the Printer's power line cord.
5. Press and hold down the FORWARD key. While holding the FORWARD key, plug in the power line cord to initiate the self-test.
6. Press the RESET button to stop the self-test. The self-test stops after printing a specific number of lines.

E.1 ISL OPTION FOR RALS

ISL Description

The intelligent software link (ISL) is a software protocol designed to allow a host system to operate the user interface portion of a Coulter instrument remotely. Since this communication involves more than a data interface, it is a separate entity from the host computer interface currently available on most instruments. The ISL is a generic design that is currently used on the MD II but may in the future be used by different Coulter instruments and with different host systems.

The initial ISL will be launched in the US only, will be used by MD II Series instruments, and will be used with Remote Automated Laboratory System (RALS), a laboratory networked system sold by MAS. Starting with MD II software revision 1.4, the ISL software will be incorporated in all MD II software.

RALS Installation, Training and Service Responsibilities

Customers will purchase the RALS from MAS. MAS will install, connect, train, and provide the key disk necessary to enable ISL communication. Coulter Corporation and Coulter Service will only be responsible for the MD II.

If problems occur with the link, the customer will call MAS first. MAS will check communication problems and determine whether the RALS is receiving the correct signals from the MD II. Coulter Service will only be called if MAS determines that the MD II is not sending the correct signals to the RALS.

Recognizing an MD II Linked to RALS

A key disk is used to enable the ISL option. An MD II that has not had the ISL option enabled appears and responds just like any other MD II, even if it is linked to a RALS. If the ISL option has been enabled, but the RALS is not active, the letters "ISL" appear after the software revision number on the Revision screen (**5 SPECIAL FUNCTIONS ▸▸ 5 SERVICE ▸▸ 6 REVISION**).

The RALS is connected to the SERIAL 1 port of the MD II, just like any other host computer system, but when the RALS is enabled, the SERIAL 1 port is no longer an ASTM Host Communication port. The Host Communication settings screen applies to the SERIAL 1 port for setting communication protocols for RALS. When the RALS is connected and active, it runs the MD II remotely, leaving the LCD screen blank and disabling the keypad. Even aspiration is initiated at the RALS terminal.

Servicing an MD II Linked to RALS

To service an MD II linked to RALS, you disable the RALS and service the MD II just like an MD II without a RALS. To disable the RALS, either disconnect the RALS cable from the MD II, or ask the supervisor of the system to disable the RALS from the terminal.

If you need a Printer for troubleshooting purposes (Service Report), you can connect the Ticket Printer attached to the RALS terminal to the MD II. You must turn on Auto printing and select the Ticket Printer option. A ticket key disk is provided with the ISL key disk. MAS enables the Ticket Printer option when they install the RALS system. Remember to turn off Auto printing when you have finished servicing the MD II.

Symbols

+24 V POWER ON signal
  location, 2.2-6
  on +24 V power supply, 2.4-9
+24 V power supply
  +24 V POWER ON signal, 2.2-6, 2.4-9
  adjustments, 2.2-6
  description, 2.2-6
  ERROR DETECTED (015) Power Supply Failure, 4.12-3, 7.4-3, C.2-1
  ERROR DETECTED (027) Aspirate Syringe Failure, 7.4-1, C.2-1
  fuses used, 2.2-6
  installation procedures, 4.12-2
  interaction with AC Power/Vacuum Relay card, 2.2-1
  interaction with Power Supply Conditioning card, 2.5-7
  location, 2.2-3, 4.4-1, 4.12-1
  location of connections, 4.12-1
  part number, 8.1-3, 8.2-3, 8.2-5
  POWERFAIL signal, 2.2-6, 2.4-10, 7.4-3
  removal procedures, 4.12-1
  replacement, 2.2-6
  schematics, 2.2-6
  table showing adjustments, A.1-1
  tools/supplies needed for replacement, 4.12-1
  verification procedures, 4.12-3

Numerics

8042 - Gate A20 Failure
  description, C.3-1

A

A/D converter
  verify operation, 4.8-2
AC Power/Vacuum Relay card
  fuses used, 2.2-2, 4.11-1
  installation procedures, 4.11-1
  interaction with AT power supply, 2.2-2, 2.2-5
  interaction with Linear Power Supply card, 2.2-2
  jumper, 2.2-5
  jumper settings, 3.2-1
  location, 2.2-3, 4.4-1
  part number, 8.1-3, 8.2-3
  removal procedures, 4.11-1
  table showing connectors and line input ranges, A.2-1
  test point and jumper locations, 2.2-3
  test point readings, 2.2-5, A.2-1
  tools/supplies needed for replacement, 4.11-1
  VAC ON signal, 2.2-2, 2.2-5
  verification procedures, 4.11-2
Ac Select switch
  AT power supply, 2.2-2
  switch settings, 3.2-1, 4.5-1
accessibility requirements
  description, 3.1-1
accessing the Service Diagnostic procedures, 4.2-1
adjustments, table of, A.1-1
AIM
  criteria results, 7.2-1, 7.2-2
  description, 7.2-3
AIM adjustment procedure
  PMI recommendations, 5.2-2
  steps, 4.28-1
amplifier noise limits
  table showing, A.1-1
aperture, bath and Aperture Electrode module
  installation procedures, 4.24-2
  interaction with Sensor Preamp Adapter card, 4.24-2
  location of components, 4.24-1
  removal procedures, 4.24-1
  tools/supplies needed for replacement, 4.24-1
  verification procedures, 4.24-3
aspiration cycle
  table of timing activities, 2.1-5
AT motherboard
  AMIBIOS beep codes, C.3-1
  description, 2.4-1
  ERROR DETECTED (013) CPU Fatal Error, 7.4-1, C.2-1
  installation procedures, 4.6-2
  jumper locations, 2.4-1, 4.6-3
  jumper settings, 2.4-1, A.2-1
  location, 2.2-3, 4.6-1
  removal procedures, 4.6-1
  System Control, 2.4-1
  table of switch and jumper settings, 2.4-1
  tools/supplies needed for replacement, 4.6-1
  verification procedures, 4.6-3
AT power supply
  Ac Select switch, 2.2-2
  description, 2.2-1
  installation procedures, 4.5-1
  location, 2.2-3

Power On/Off switch, 2.2-1, 2.2-2
removal procedures, 4.5-1
replacement, 2.2-1
schematics, 2.2-1
table of output connectors, 2.2-1
tools/supplies needed for replacement, 4.5-1
verification procedures, 4.5-2
AT select switch
switch settings, 3.2-1
attention
definition, 1.1-2
Auto Print function
description, 7.2-1

B

Base 64 KB Memory Failure
description, C.3-1
beep codes
1 Refresh Failure, C.3-1
10 CMOS Shutdown Register Read/Write Error, C.3-1
2 Parity Error, C.3-1
3 Base 64 KB Memory F, C.3-1
4 Timer Not Operational, C.3-1
5 Processor Error, C.3-1
6 8042 - Gate A20 Failure, C.3-1
7 Processor Exception Interrupt Error, C.3-1
8 Display Memory Read/Write Error, C.3-1
9 ROM Checksum Error, C.3-1
definition, C.3-1
table showing motherboard AMIBIOS beep codes, C.3-1

C

calibration factor limits
table showing, A.1-1
caution
definition, 1.1-2
circuit cards
AC Power/Vacuum Relay. *See* AC Power/Vacuum Relay card
AT motherboard. *See* AT motherboard
DRA. *See* DRA card
Flex Connect. *See* Flex Connect card
Hgb Preamp. *See* Hgb Preamp card
Linear Power Supply. *See* Linear Power Supply card
Motor/Solenoid Driver. *See* Motor/Solenoid Driver card
Probe/Opto Sensor. *See* Probe/Opto Sensor card
Sensor Preamp Adapter. *See* Sensor Preamp Adapter card
Solenoid Interconnect. *See* Solenoid Interconnect card
SPAD. *See* SPAD card
URA. *See* URA card
Vacuum Sensor. *See* Vacuum Sensor card
CLEAN BATHS
description, 7.1-1
cleaning
bleach the baths and apertures, 5.2-1
dust, 5.2-1
PMI recommendations, 5.2-1
salt deposits, 5.2-1
CLEAR APERTURES
description, 7.1-1
CMOS RAM
10 CMOS Shutdown Register Read/Write Error, C.3-1
description, 2.4-3
ERROR DETECTED (006) Insufficient RAM, 7.4-2, C.2-1
ERROR DETECTED (011) URA CMOS Failure, 7.4-5, C.2-1
ERROR DETECTED (012) System Disk File Corrupt, 7.4-4, 7.4-5, C.2-1
errors, 2.4-3
function, 2.4-3
location, 2.4-5
PD.DAT file, 7.4-4
URA card, 2.4-3
verification, 2.4-3
CMOS Shutdown Register Read/Write Error
description, C.3-1
connect the reagents
locations, 3.2-2
procedures, 3.2-2
COULTER MD II Series Analyzer
description, 2.1-1
functional divisions, 2.1-1
operation, 2.1-1
cycle counter
description, 2.3-7
location on Fluidics Panel, 2.3-1
part number, 8.1-2, 8.2-2

D

Data Acquisition section
- functional relationship, 2.1-1

Diagnostic Data Acquisition circuit
- description, 2.4-4

diluent reservoir
- description, 2.3-7
- location on Fluidics Panel, 2.3-1

Diluter Functions menu options
- CLEAN BATHS, 7.1-1
- CLEAR APERTURES, 7.1-1
- DISPENSE LYSE, 7.1-1
- DRAIN, 7.1-1
- MIX, 7.1-1
- RINSE, 7.1-1

Diluter Panel
- aperture system, 2.3-2
- components, 2.3-2
- description, 2.3-2
- fluidic solenoids, 2.3-1, 2.3-4
- Hgb LED, 2.3-2
- interaction with Sensor Preamp Adapter card, 2.3-2
- location of components, 2.3-2
- location on Fluidics Panel, 2.3-1
- parts explosion, 8.2-8
- RBC bath, 2.3-2
- solenoids, 2.3-1, 2.3-4
- sweep-flow system, 2.3-2
- VIC, 2.3-2
- WBC bath, 2.3-2

Diluter Panel solenoids
- installation procedures, 4.25-1
- interaction with Solenoid Interconnect card, 4.25-1
- removal procedures, 4.25-1
- Service Diagnostic, 4.25-1
- tools/supplies needed for replacement, 4.25-1
- verification procedures, 4.25-1

Diluter Resource Adapter card. *See* DRA card

diluter table
- aspiration cycle, 2.1-5
- function, 2.1-2
- power-up cycle, 2.1-6
- Service Diagnostic, 7.1-2
- timing chart, 2.1-4
- troubleshooting using, 2.1-4

DISPENSE LYSE
- description, 7.1-1

display
- description, 2.6-1
- installation procedures, 4.10-2
- interaction with URA card, 2.4-2
- location, 2.2-3, 4.10-1
- location of connectors, 4.10-1
- part number, 8.1-6, 8.2-2
- removal procedures, 4.10-1
- tools/supplies needed for replacement, 4.10-1
- troubleshooting, 2.6-1
- verification procedures, 4.10-2
- verify operation, 4.8-2

display controller
- description, 2.4-3
- URA card, 2.4-3

Display Memory Read/Write Error
- description, C.3-1

Document Control Numbers (DCN)
- for schematics/diagrams included in this manual, 6.1-1
- for schematics/diagrams not included in this manual, 6.1-1

DRA card
- components, 2.4-6
- description, 2.4-6
- ERROR DETECTED (003) DRA Board Failure, 7.4-2, C.2-1
- installation procedures, 4.9-2
- interaction with AT motherboard, 2.4-7
- interaction with Motor/Solenoid Driver card, 2.4-6
- jumper locations, 2.4-8
- jumper locations and settings, 4.9-1
- jumper settings, 4.9-2, A.2-2
- location, 2.2-3, 4.6-1, 4.9-2
- motor controller, 2.4-6
- part number, 8.1-6, 8.2-4
- removal procedures, 4.9-1
- solenoids, 2.4-6, 2.4-7
- stepper motor, 2.4-7
- stepper motors, 7.4-2
- support circuitry, 2.4-7
- System Control, 2.4-1
- table of jumper settings, 2.4-8, A.2-2
- table of output connectors, 2.4-7
- tools/supplies needed for replacement, 4.9-1
- verification procedures, 4.9-2

DRAIN
- description, 7.1-1

Drain, 2.1-6

E

electronic signals
+24 V POWER ON signal, 2.2-6, 2.4-9
HEMOGLOBIN signal, 2.5-3
HGB VOLTAGE (+5 V), 2.4-4
LYSE PUMP signal, 2.4-9
PLT PREAMP signal, 2.5-9
PLT signal, 2.5-2
POWERFAIL (PF/PG) signal, 2.4-8
POWERFAIL signal, 2.2-6, 2.4-10, 7.4-3
RBC 26-PERCENTILE VOLTAGE, 2.4-4
RBC APERTURE VOLTAGE, 2.4-4
RBC PREAMP signal, 2.5-9
RBC signal, 2.5-2
RBC/PLT APERTURE signal, 2.5-1
VAC ON signal, 2.2-2, 2.2-5
VACUUM READING (+12 V), 2.4-4
VACUUM SENSOR signal, 2.4-5
WBC 26-PERCENTILE VOLTAGE (+15 V), 2.4-4
WBC APERTURE signal, 2.5-1
WBC APERTURE VOLTAGE, 2.4-4
WBC PREAMP signal, 2.5-9
WBC signal, 2.5-2
electrostatic discharge
warning, 1.2-1
Epson, 3.2-3
ERROR DETECTED (010), 7.4-2
ERROR DETECTED (021), 7.4-4
error messages, 7.4-2, 7.4-4
BIOS settings, 7.4-4
ERROR DETECTED (003) DRA Board Failure, 7.4-2, C.2-1
ERROR DETECTED (004) SPAD Board Failure, 7.4-4, C.2-1
ERROR DETECTED (005) System Disk File Corrupt, 7.4-4, C.2-1
ERROR DETECTED (006) Insufficient RAM, 7.4-2, C.2-1
ERROR DETECTED (008) URA Board Failure, 7.4-5, C.2-1
ERROR DETECTED (009) URA Board Failure, 7.4-5, C.2-1
ERROR DETECTED (011) URA CMOS Failure, 7.4-5, C.2-1
ERROR DETECTED (012) System Disk File Corrupt, 7.4-4, 7.4-5, C.2-1
ERROR DETECTED (013) CPU Fatal Error, 7.4-1, C.2-1
ERROR DETECTED (014) Power Supply Failure, 7.4-2, C.2-1
ERROR DETECTED (015) Power Supply Failure, 4.12-3, 7.4-3, C.2-1
ERROR DETECTED (016) System Disk File Corrupt, 7.4-4
ERROR DETECTED (017) Unable to Sense Diluent Level, 2.1-6, 7.4-5, C.2-1
ERROR DETECTED (018) Copy Protection Violation, 7.4-1, C.2-1
ERROR DETECTED (019) System Disk File Corrupt, 7.4-4, C.2-1
ERROR DETECTED (020) Count Period Timeout, 7.4-1, C.2-1
ERROR DETECTED (021) Software Timer Error, 7.4-4, C.2-1
ERROR DETECTED (026) Aspirate Syringe Failure, 7.4-1, C.2-1
ERROR DETECTED (027) Aspirate Syringe Failure, 7.4-1, C.2-1
ERROR DETECTED (028) Diluent Syringe Failure, 7.4-1, C.2-1
ERROR DETECTED (029) Diluent Syringe Failure, 7.4-1, C.2-1
ERROR DETECTED (030) Probe Mechanism Failure, 7.4-3, C.2-1
ERROR DETECTED (031) Probe Mechanism Failure, 7.4-3, C.2-2
ERROR DETECTED (032) Probe Mechanism Failure, 7.4-3, C.2-2
ERROR DETECTED (033) Probe Mechanism Failure, 7.4-3, C.2-2
ERROR DETECTED (034) Probe Mechanism Failure, 7.4-3, C.2-2
ERROR DETECTED (037) Software Fatal Error, 7.4-4, C.2-2
ERROR DETECTED (038) RAM Drive Failure, 7.4-4, C.2-2
ERROR DETECTED (039) SPAD Board Failure, 7.4-4, C.2-2
Hgb Blank Voltage High, 7.4-2, C.1-1
Hgb Blank Voltage Low, 7.4-2, C.1-1
Software Fatal Error, 7.4-2, 7.4-5
table showing fatal error messages, C.2-1
table showing non-fatal error messages, C.1-1
Unable to Create INF File, C.1-1
Vacuum Out of Range, 7.4-5, C.1-1

F

filters
- PMI recommendations, 5.2-1

Flex Connect card
- function, 2.3-7
- interaction with Probe/Wipe Traverse Assembly, 2.3-7
- LED power indicator, 2.3-7
- location, 2.2-3, 4.4-1
- part number, 8.1-4, 8.2-3
- solenoids, 2.3-7
- table of connectors, solenoids, LEDs, 2.3-7

floppy drive
- description, 2.6-1
- ERROR DETECTED (018) Copy Protection Violation, 7.4-1, C.2-1
- location, 2.2-3
- part number, 8.1-6, 8.2-4
- verify operation, 4.6-4

fluid reservoir
- Fluidics Panel, 2.3-7

fluidic solenoids
- Diluter Panel, 2.3-1, 2.3-4
- table showing name, type, function, 2.3-4

Fluidics Panel
- components, 2.3-1
- cycle counter, 2.3-7
- fluid reservoir, 2.3-7
- function, 2.3-1
- internal seals, 2.3-8
- location, 2.3-1
- location of components, 2.3-1
- lyse pump, 2.3-8
- vacuum regulator, 2.3-9

Fluidics Panel section
- functional relationship, 2.1-1

fuses
- on +24 V power supply, 2.2-6
- on AC Power/Vacuum Relay card, 2.2-2
- part numbers, 8.1-3, 8.2-5

H

HEMOGLOBIN signal
- Hgb Preamp card, 2.5-3

Hgb
- sample analysis of results, 7.2-3

Hgb Blank Voltage High
- description, C.1-1

Hgb Blank Voltage Low
- description, C.1-1

Hgb Preamp adjustment procedure
- PMI recommendations, 5.2-2
- steps, 4.29-1
- tools/supplies needed for replacement, 4.29-1

Hgb Preamp card
- adjustments, 2.5-3, 2.5-4
- description, 2.5-3
- HEMOGLOBIN signal, 2.5-3
- location, 2.2-3, 4.4-1
- part number, 8.1-4, 8.2-3
- table showing adjustments, A.1-1
- test points, 2.5-4, A.2-2
- VOLTAGE READINGS, 7.1-2

hidden menu items for service
- location, 2.1-2

I

important
- definition, 1.1-2

initial setup of instrument
- calibrate the instrument, 3.3-1
- connect the Printer, 3.2-3
- peristaltic pump tubing, 3.2-1
- startup the instrument, 3.3-1
- unpack the instrument, 3.2-1

installation procedures
- instrument, 3.2-1
- optional Printers, 3.4-1

instrument cycling
- description, 2.1-2

intelligent software link (ISL) option
- description, E.1-1

J

jumper settings
- AC Power/Vacuum Relay card, 2.2-5, 3.1-2, 3.2-1, A.2-1
- AT motherboard, 2.4-1, A.2-1
- DRA card, 2.4-8, A.2-2
- Linear Power Supply card, 2.2-8, A.2-2
- Motor/Solenoid Driver card, 2.4-11, A.2-3
- Sensor Preamp Adapter card, 2.5-2, A.2-4
- URA card, 2.4-6, A.2-4

K

keypad
- 8279 keyboard controller chip, 2.4-3
- description, 2.6-1
- input connector, 2.4-5
- installation procedures, 4.10-2
- interaction with URA card, 2.4-2
- location, 2.2-3, 4.10-1
- location of connectors, 4.10-1
- part number, 8.1-6, 8.2-2
- removal procedures, 4.10-1
- replacement, 2.6-1
- Software Fatal Error, 7.4-2, 7.4-4
- tools/supplies needed for replacement, 4.10-1
- verification procedures, 4.10-2
- verify operation, 4.8-2

keypad controller
- description, 2.4-3

Keypad Failure, 7.4-2

L

LATEX GAIN
- description, 7.1-2

latex gain adjustment procedure
- Linear Power Supply card, 2.2-7
- PMI recommendations, 5.2-2

LEDs
- Hgb LED, 2.2-8, 2.3-2
- Hgb LED current, 2.2-1, 4.13-3
- Motor/Solenoid Driver card, 2.4-9
- on Flex Connect card, 2.3-7
- Solenoid Interconnect card, 2.3-8

limits
- amplifier noise, table of, A.1-1
- calibration factors, table of, A.1-1

Linear Power Supply card
- description, 2.2-6
- Hgb LED, 2.2-8
- installation procedures, 4.13-2
- interaction with Sensor Preamp Adapter card, 4.13-3
- interaction with SPAD card, 2.2-7
- jumper locations and settings, 2.2-7, 4.13-1
- jumper settings, 2.2-8, 4.13-2
- latex gain adjustment procedure, 2.2-7
- LED locations, 2.2-7
- location, 2.2-3, 4.4-1, 4.13-2
- location of test points and jumpers, 4.13-2
- part number, 8.1-3, 8.2-3, 8.2-5
- removal procedures, 4.13-1
- table of test points, 2.2-8, A.2-2
- table showing jumper settings, A.2-2
- test point locations, 2.2-7, 4.13-1
- tools/supplies needed, 4.13-1
- verification procedures, 4.13-3
- verify voltages, 4.11-2

lower chassis
- opening, 2.2-3

lyse pump
- description, 2.3-8
- Fluidics Panel, 2.3-8
- location on Fluidics Panel, 2.3-1
- Motor/Solenoid Driver card, 2.4-9

LYSE PUMP signal
- function, 2.4-9

lyse system
- troubleshooting, 2.3-8

lyse volume adjustment/verification procedure
- tools/supplies needed, 4.31-1
- when to perform, 4.31-1

M

manual
- conventions, 1.1-2
- organization, 1.1-1
- scope, 1.1-1
- special headings, 1.1-1

manuals, customer
- part numbers, 1.1-1

MIX
- description, 7.1-1

Motor
- Motor/Solenoid Driver card, 2.4-9

Motor/Solenoid Driver card
- description, 2.4-8
- installation procedures, 4.15-1
- interaction with DRA cards, 2.4-8, 2.4-9
- jumper locations and settings, 4.15-2
- LED, 2.4-9
- location, 2.2-3, 4.4-1
- lyse pump, 2.4-9
- part number, 8.1-3, 8.2-3
- POWERFAIL signal, 2.4-10
- removal procedures, 4.15-1
- Service Diagnostic, 4.15-3
- solenoid driver, 2.4-9
- System Control, 2.4-1

table of input connectors, 2.4-10
table of jumper settings, 2.4-11, A.2-3
table of output connectors, 2.4-10
table of test points, 2.4-11, A.2-3
table showing jumper settings, A.2-3
tools/supplies needed, 4.15-1
unpacking the instrument, 3.2-1
verification procedures, 4.15-2

motors
DRA card, 2.4-6, 2.4-7
interaction with DRA card, 7.4-2
Motor/Solenoid Driver card, 2.4-9
peristaltic pump motors, 4.22-2
probe motor, 2.3-4, 2.4-9
stepper motor, 2.3-4, 2.3-6, 2.4-6, 2.4-7
Syringe Assembly, 4.21-3
traverse motor, 2.3-4, 2.4-10, 4.20-1, 4.20-2

N

note
definition, 1.1-2

O

octal DAC
description, 2.5-8

opening the lower chassis
procedures, 4.4-1

optional ticket printer
installation, 3.4-1
locations of connections, 3.2-3

Oscillator circuit
description, 2.5-7
SPAD card, 2.5-7

P

Parity Error
description, C.3-1

part numbers
cables, 8.1-1
customer manuals, 1.1-1
fuses, 8.1-3
lower chassis items, 8.1-2, 8.1-3, 8.1-4
miscellaneous hardware items, 8.1-7, 8.1-8
peripherals and support items, 8.1-5
upper chassis items, 8.1-6

PD.DAT file
CMOS RAM, 2.4-3
errors, 2.4-3

peripherals
display, 2.6-1
floppy drive, 2.6-1
keypad, 2.6-1

Peripherals section
functional relationship, 2.1-1

Peristaltic Pump Assembly
components, 2.3-5
description, 2.3-5
location on Fluidics Panel, 2.3-1
parts explosion, 8.2-12
peristaltic pump motors, 4.22-2
table showing location and function, 2.3-6

peristaltic pump motor and spool
installation procedures, 4.22-2
location, 4.22-1
location of components, 4.22-1
removal procedures, 4.22-1
tools/supplies needed for replacement, 4.22-1
verification procedures, 4.22-2

peristaltic pump tubing
PMI recommendations, 5.2-1

peristaltic pumps
on Fluidics Panel, 2.3-1
table showing location and function, 2.3-6, A.4-1
verify operation, 4.9-2, 4.15-3, 4.22-2

PLT PREAMP signal
table showing SPAD card connections, 2.5-9

PLT signal
table showing Sensor Preamp Adapter card connections, 2.5-2

PMI recommendations
AIM Adjustment procedure, 5.2-2
cleaning, 5.2-1
filters, 5.2-1
Hgb preamp adjustment procedure, 5.2-2
latex gain adjustment procedure, 5.2-2
peristaltic pump tubing, 5.2-1
polyurethane tubing, 5.2-1
syringes, 5.2-1
verification procedures, 5.2-2

polyurethane tubing
PMI recommendations, 5.2-1

positioning, 7.4-3

power, 2.1-6

power ranges, 3.1-1
table showing connector and power ranges, A.2-1

table showing connector, power ranges, part numbers, 3.1-2
power supplies
+24 V power supply, 2.2-6
AT power supply, 2.2-1
description, 2.2-1
ERROR DETECTED (014) Power Supply Failure, 7.4-2, C.2-1
ERROR DETECTED (015) Power Supply Failure, 4.12-3, 7.4-3, C.2-1
fuses used, 2.2-1
input/output voltage, 2.2-1
interaction with DRA card, 2.2-1
interaction with Linear Power Supply card, 2.2-1
interaction with Motor/Solenoid Driver card, 2.2-1
Linear Power Supply card, 2.2-6
Power Supply Conditioning card
description, 2.5-7
interaction with +24 V power supply, 2.5-7
Power Supply section
functional relationship, 2.1-1
POWERFAIL signal, 2.4-8
interaction with Motor/Solenoid Driver card, 2.4-10
location, 2.2-6
on +24 V power supply, 2.4-10
power-up cycle
table of timing activities, 2.1-5
preinstallation checks
accessibility requirements, 3.1-1
power requirements, 3.1-1
space requirements, 3.1-1
table showing space requirements, 3.1-1
Printer
CITIZEN GSX-190 part number, 8.1-5, 8.2-5
CITIZEN GSX-190 settings, 3.2-4, A.3-1
connecting, 3.2-3
Epson TM-290P Slip Printer DIP switch settings, D.1-2
Epson TM-290P Slip Printer operator controls, D.1-1
Epson TM-290P Slip Printer self test, D.1-2
Epson TM-290P Slip Printer specifications, D.1-1
ERROR DETECTED (017) Unable to Sense Diluent Level, C.2-1
ERROR DETECTED (019) System Disk File Corrupt, C.2-1
installing Graphic only, 3.2-3
installing Ticket and Graphic, 3.4-3
installing Ticket only, 3.4-1
locations of connections, 3.2-3
verify operation of port, 4.6-4
probe and probe wipe
installation procedures, 4.17-2
location of components, 4.17-1
removal procedures, 4.17-1
tools/supplies needed for replacement, 4.17-1
verification procedures, 4.17-3
probe motor, 7.4-3
installation procedures, 4.18-1
interaction with Probe/Opto Sensor card, 4.18-1
Motor/Solenoid Driver card, 2.4-9
Probe/Wipe Traverse Assembly, 2.3-4
removal procedures, 4.18-1
tools/supplies needed for replacement, 4.18-1
verification procedure, 4.18-1
Probe/Opto Sensor card
interaction with probe motor, 4.18-1
part number, 8.1-4, 8.2-7
Probe/Wipe Traverse Assembly
adjustments, 2.3-4
components, 2.3-4
ERROR DETECTED (030) Probe Mechanism Failure, 7.4-3, C.2-1
ERROR DETECTED (031) Probe Mechanism Failure, 7.4-3, C.2-2
ERROR DETECTED (032) Probe Mechanism Failure, 7.4-3, C.2-2
ERROR DETECTED (033) Probe Mechanism Failure, 7.4-3, C.2-2
ERROR DETECTED (034) Probe Mechanism Failure, 7.4-3, C.2-2
function, 2.3-1, 2.3-4
interaction with Flex Connect card, 2.3-7
location of components, 2.3-4
location on Fluidics Panel, 2.3-1
part number, 8.1-4
parts explosion, 8.2-6
probe motor, 2.3-4
traverse motor, 2.3-4
procedures
accessing hidden service menu items, 4.2-1
accessing the Service Disgnostic, 4.2-1
accessing the Service Report, 4.2-1
AIM adjustment, 4.28-1
calibration, 3.3-1

connecting the Printer, 3.2-3
connecting the reagents, 3.2-2
entering the initial instrument settings, 3.2-4
Hgb preamp adjustment, 4.29-1
latex gain adjustment, 2.2-7, 4.27-1, 7.1-2
lyse volume adjustment/verification, 7.1-1
opening the lower chassis, 4.4-1
rebooting the system, 4.2-2
removing the top cover, 4.3-1
Service Diagnostic, 7.3-1
starting the instrument, 3.3-1
system verification, 5.1-1
unpacking the instrument, 3.2-1
vacuum adjustment, 4.14-2, 4.23-1, 4.30-1
Processor Error
description, C.3-1
Processor Exception Interrupt Error
description, C.3-1
PULSE TEST
description, 7.1-2
Service menu options, 7.1-2
SPAD card, 4.7-2
pumps
lyse pump, 2.3-8, 2.4-9
peristaltic pumps, 2.3-1, 2.3-5, A.4-1
vacuum pump, 2.2-5
pumps/peristaltic pumps, 2.3-6

R

RBC bath
activity on power-up cycle, 2.1-6
description, 2.3-2
RBC PREAMP signal
table showing SPAD card connections, 2.5-9
RBC signal
table showing Sensor Preamp Adapter card connections, 2.5-2
RBC/PLT APERTURE signal
table showing Sensor Preamp Adapter card connections, 2.5-1
rear panel interface connectors
parallel printer connector, 2.6-1
Serial 1 connector, 2.6-1
Serial 2 connector, 2.6-1
rebooting the system
procedures, 4.2-2
Refresh Failure
description, C.3-1
Remote Automated Laboratory System (RALS)
servicing MD II with, E.1-1
removal/installation/verification procedures
guidelines, 4.1-1
removing the top cover
procedures, 4.3-1
REPLACE SYRINGE
description, 7.1-2
reproducibility and carryover
PMI recommendations, 5.2-2
System Verification Procedure, 5.2-2
REVISION LEVELS
description, 7.1-2
RINSE
description, 7.1-1
ROM Checksum Error
description, C.3-1

S

safety precautions
biological, 1.2-1
electronic, 1.2-1
troubleshooting, 1.2-2
schematics/diagrams
table showing those included in this manual, 6.1-1
table showing those not included in this manual, 6.1-1
Sensor Preamp Adapter card
adjustments, 2.5-2
description, 2.5-1
installation procedures, 4.16-2
interaction with Diluter Panel, 2.3-2
interaction with SPAD card, 2.5-1
jumper locations and settings, 2.5-2, 4.16-3
jumper settings, 4.16-2
location, 2.2-3, 4.4-1, 4.16-1
part number, 8.1-3, 8.2-3
PULSE TEST, 7.1-2
removal procedures, 4.16-1
table of input connectors, 2.5-1
table of jumper settings, 2.5-2, A.2-4
table of output connectors, 2.5-2
tools/supplies needed for replacement, 4.16-1
verification procedures, 4.16-3
Sensor Processing Adapter with Diagnostics card. *See* SPAD card
Serial 1 connector
function, 2.6-1
table of pinouts, 2.6-1

Serial 2 connector
- function, 2.6-1
- table of pinouts, 2.6-1

serial ports
- Serial 1, 2.6-1
- Serial 2, 2.6-1
- table of pinouts, 2.6-1
- verify operation of port, 4.6-4

Service Diagnostic
- description, 7.1-2, 7.3-1
- Diluter Panel solenoids, 4.25-1
- diluter table, 2.1-2
- interaction with Vacuum Sensor card, 7.3-1
- Motor/Solenoid Driver card, 4.15-3
- procedures, 7.3-1
- table showing cycle, 7.3-1
- verify operation of solenoid valves, 4.9-2

Service menu options
- LATEX GAIN, 7.1-2
- PULSE TEST, 7.1-2
- REPLACE SYRINGE, 7.1-2
- REVISION LEVELS, 7.1-2
- Service Diagnostic, 7.1-2
- VACUUM ADJUST, 7.1-2
- VOLTAGE READINGS, 7.1-2

Service Report
- procedures to generate, 7.2-1
- sample Service Report, 7.2-1

software menu system
- description, 2.1-2
- hidden menu items for service, 2.1-2
- software menu tree, 2.1-2

software menu tree
- illustration, 2.1-2, A.5-1

software tables
- diluter table, 2.1-2
- function, 2.1-2
- instrument cycling, 2.1-2

Software Timer Error, 7.4-4

solenoid controller
- DRA card, 2.4-7

Solenoid Interconnect card
- description, 2.3-8
- location, 2.2-3, 4.4-1
- part number, 8.1-4, 8.2-3
- table of connectors, solenoids, LEDs, 2.3-8

solenoid valves
- Vacuum Sensor card, 2.5-4, 2.5-5

solenoids
- Diluter Panel, 2.3-2
- DRA card, 2.4-6, 2.4-7
- fluidic solenoids, 2.3-1, 2.3-4
- Motor/Solenoid Driver card, 2.4-9
- on Flex Connect card, 2.3-7

space requirements
- description, 3.1-1
- table showing space requirements, 3.1-1

SPAD card
- aperture signal processing, 2.5-8
- control functions, 2.5-7
- control signals/commands, 2.5-7
- description, 2.5-6
- ERROR DETECTED (004) SPAD Board Failure, 7.4-4, C.2-1
- ERROR DETECTED (039) SPAD Board Failure, 7.4-4, C.2-2
- input connector, 2.5-9
- installation procedures, 4.7-1
- interaction with AT motherboard, 2.5-7
- interaction with Linear Power Supply card, 2.5-7
- interaction with Sensor Preamp Adapter card, 2.5-6
- interrupt selector, 2.5-9
- jumper location and setting, 2.5-9
- jumper setting, 4.7-1
- jumper settings, A.2-4
- location, 2.2-3, 4.6-1, 4.7-1
- location of connectors, 2.5-9
- octal DAC, 2.5-8
- Oscillator circuit, 2.5-7
- part number, 8.1-6, 8.2-4
- power supply conditioning, 2.5-7
- Power Supply Conditioning card, 2.5-7
- PULSE TEST, 4.7-2, 7.1-2
- removal procedures, 4.7-1
- table showing adjustments, A.1-1
- test pulse generator, 2.5-9
- tools/supplies needed for replacement, 4.7-1
- verification procedures, 4.7-2

special headings, 1.1-1
- attention, 1.1-2
- caution, 1.1-2
- important, 1.1-2
- note, 1.1-2
- warning, 1.1-1

stepper motor, 7.4-2
- DRA card, 2.4-6
- location on Syringe Assembly, 2.3-6

SVP, 5.1-1
sweep-flow system
  Diluter Panel, 2.3-2
sweep-flow tubing
  installation procedures, 4.26-2
  interaction with Diluter Panel, 4.26-1
  location, 4.26-1
  location of components, 4.26-1
  part number, 4.26-2
  removal procedures, 4.26-1
  tools/supplies needed for replacement, 4.26-1
  verification procedures, 4.26-2
switch settings
  Ac Select switch, 3.2-1
  AT motherboard, 2.4-1, A.2-1
  URA card, 2.4-6, A.2-4
switches
  Ac Select switch, 2.2-2
  instrument's power ON/OFF switch, 2.2-1, 2.2-2
Syringe Assembly
  components, 2.3-6
  description, 2.3-6
  ERROR DETECTED (026) Aspirate Syringe Failure, 7.4-1, C.2-1
  ERROR DETECTED (027) Aspirate Syringe Failure, 7.4-1, C.2-1
  ERROR DETECTED (028) Diluent Syringe Failure, 7.4-1, C.2-1
  ERROR DETECTED (029) Diluent Syringe Failure, 7.4-1, C.2-1
  installation procedures, 4.21-3
  location of components, 2.3-6
  location on Fluidics Panel, 2.3-1
  part number, 8.1-4
  parts explosion, 8.2-10
  removal procedures, 4.21-1
  stepper motor, 2.3-6
  tools/supplies needed for replacement, 4.21-1
  verification procedures, 4.21-4
syringes
  PMI recommendations, 5.2-1
System Control section
  AT motherboard, 2.4-1
  components, 2.4-1
  DRA card, 2.4-1
  functional relationship, 2.1-1
  Motor/Solenoid Driver card, 2.4-8
  URA card, 2.4-1, 2.4-2
system verification procedure, 5.1-1

T

Timer Not Operational
  description, C.3-1
timing chart
  diluter table, 2.1-4
  for troubleshooting, 2.1-4
top cover
  removing, 2.2-3
traverse drive belt
  installation procedures, 4.19-2
  removal procedures, 4.19-1
  tools/supplies needed, 4.19-1
  verification procedures, 4.19-3
traverse motor
  installation procedures, 4.20-2
  location of components, 4.20-1
  Motor/Solenoid Driver card, 2.4-9
  Probe/Wipe Traverse Assembly, 2.3-4
  removal procedures, 4.20-1
  tools/supplies needed for replacement, 4.20-1
  verification procedures, 4.20-3
troubleshooting
  display, 2.6-1
  generating a Service Report, 7.2-1
  lyse system, 2.3-8
  safety precautions, 1.2-2
  sample screen display, 7.2-1
  sample Service Report, 7.2-1
  Service Diagnostic, 7.3-1
  table showing Diluter Functions menu options, 7.1-1
  table showing Service Diagnostic cycle, 7.3-1
  table showing Service menu options, 7.1-2
  using timing chart, 2.1-4

U

Unable to Create INF File, 7.4-5
  description, C.1-1
URA card
  adjustments, 2.4-5
  CMOS RAM, 2.4-3, 7.4-4
  components, 2.4-2
  description, 2.4-2
  Diagnostic Data Acquisition circuit, 2.4-4
  display, 2.4-2
  display controller, 2.4-3
  ERROR DETECTED (008) URA Board Failure, 7.4-5, C.2-1

ERROR DETECTED (009) URA Board Failure, 7.4-5, C.2-1
ERROR DETECTED (011) URA CMOS Failure, 7.4-5, C.2-1
ERROR DETECTED (012) System Disk File Corrupt, 7.4-5, C.2-1
ERROR DETECTED (016) System Disk File Corrupt, 7.4-4
input/output voltage, 2.4-4
installation procedures, 4.8-2
jumper and switch settings, 4.8-2
jumper location and setting, 2.4-5, 4.9-1
keypad controller, 2.4-4
location, 2.2-3, 4.6-1, 4.8-2
part number, 8.1-6, 8.2-4
removal procedures, 4.8-1
Software Fatal Error, 7.4-2, 7.4-5
support circuitry, 2.4-4
System Control, 2.4-1
table showing adjustments, A.1-1
table showing switch and jumper settings, A.2-4
tools/supplies needed for replacement, 4.8-1
Unable to Create INF File, 7.4-5
Utility Timer circuit, 2.4-4
verification procedures, 4.8-2
User Resource Adapter card. *See* URA card
Utility Timer circuit
description, 2.4-4
location, 2.4-5

V

VAC ON signal
AC Power/Vacuum Relay card, 2.2-2, 2.2-5
location, 2.2-3
VACUUM ADJUST
description, 7.1-2
vacuum adjustment procedure
steps, 4.30-1
Vacuum Sensor card, 4.14-2
Vacuum Out of Range
description, 7.4-5, C.1-1
vacuum pump
AC Power/Vacuum Relay card, 2.2-5
installation procedures, 4.23-1
location, 2.2-4, 4.4-1
part number, 8.1-4, 8.2-3
removal procedures, 4.23-1
tools/supplies needed for replacement, 4.23-1
unpacking the instrument, 3.2-1
VACUUM ADJUST, 7.1-2
verification procedures, 4.23-1
vacuum regulator
adjustment, 2.3-9
description, 2.3-9
location on Fluidics Panel, 2.3-1
part number, 8.1-3, 8.2-2
Vacuum Sensor card
adjustments, 2.5-5
function, 2.5-4
input/output voltage, 2.5-4
installation procedures, 4.14-2
location, 2.2-3, 4.4-1
location of connectors, 2.5-6
part number, 8.1-3, 8.2-3
removal procedures, 4.14-1
Service Diagnostic, 7.3-1
solenoid valves, 2.5-4
table of test points, 2.5-6, A.2-4
test point locations, 2.5-6
tools/supplies needed for replacement, 4.14-1
vacuum adjustment procedure, 4.14-2
verification procedures, 4.14-2
VACUUM SENSOR signal
location, 2.4-5
VIC
description, 2.3-2
function, 2.5-4
part number, 8.1-4, 8.2-9
tube removal, 4.14-2
VOLTAGE READINGS
description, 7.1-2

W

warning
definition, 1.1-1
WBC APERTURE signal
table showing Sensor Preamp Adapter card connections, 2.5-1
WBC bath
activity on power-up cycle, 2.1-6
description, 2.3-2
WBC PREAMP signal
table showing SPAD card connections, 2.5-9
WBC signal
table showing Sensor Preamp Adapter card connections, 2.5-2

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